

## SCJAS ORAL PRESENTATION ABSTRACTS (Listed alphabetically by presenter's last name)

### DETERMINING THE AMOUNTS OF BACTERIA PRESENT IN MEAT POST VARIOUS FORMS OF COOKING AND THAWING

Roann Abdeladl  
Greenville Technical Charter High School

Safety of meat is a prevalent concern in modern society that raises several questions regarding health and cooking meat. When thawing and cooking meat, many often make crucial mistakes that cause the propagation of dangerous bacteria. Building on research from previous years, in this experiment, I tested the various levels of bacteria in meat after utilizing different thawing and cooking methods. I tested bacterial levels in meat thawed at room temperature and in the refrigerator; I also determined bacterial colony counts in meat cooked in the microwave versus meat cooked on the stove top. After sterilizing samples of treated meat, I incubated the meat samples on petri dishes and used a microscope to determine the colony counts on the plate. The results demonstrated that meat thawed at room temperature had 23% more bacteria than meat thawed in the refrigerator; additionally, the meat cooked in the microwave had 19.6% more bacteria than that cooked on the stove top. By applying this knowledge, one should take measures to thaw meat in the refrigerator and cook meat on the stove top.

### EFFECT OF THICKNESS OF COPPER PLATING ON ANTIMICROBIAL PROPERTIES AGAINST *S. AUREUS*

Adam Abdulrahman  
Chapin High School

Copper has significant antimicrobial effects (1,2). The implementation of copper into a hospital setting has also shown a dramatic decrease in infection rates (3). This study is focused on the use of varying thicknesses of plated copper on 4x4cm steel plates and whether the varying thickness is independent of the antimicrobial action on *S. aureus*. Two primary steps were necessary for experimentation. The first was to copper plate the steel plates by an electrolytic cell, comprised of a copper rod anode connected to the positive terminal of the power supply and the steel plate cathode connected to the negative, suspended in a Copper Sulfate Pentahydrate solution. The second is the inoculation and incubation of agar plates by samples of *S. aureus* taken from copper plates. Further research is necessary at lower dilutions of the *S. aureus* sample before incubation, as the initial incubations had counts significantly greater than 300 colonies. If the proper bacterial counts are successful, no significant correlation between thickness and antimicrobial action would suggest that even at low thicknesses, copper retains its antimicrobial effects on *S. aureus*. This means that my hypothesis would be confirmed, and that an increase in thickness has no added antimicrobial action. This could potentially suggest that hospitals could implement copper plated handles in susceptible areas, such as hand rails, instead of copper alloys, such as bronze, which would be more expensive. The increased cost effectiveness could potentially increase the implementation of such plating, further decreasing infection rates in hospitals.

### IMPROVING EVACUATED TUBES

Maeghan Ainsworth  
Center for Advanced Technical Studies

How can changing the insulation material of an evacuated tube effect the maximum temperature reached by the water being heated? If there is a change in the type of insulation, then the maximum temperature reached will change. Evacuated tubes are being used because they are the best for solar heating. It is predicted that the lower the R value, the higher the maximum temperature reached by the water will be. This is being completed to help areas where clean water is scarce, like many areas Africa. Cheaper models of evacuated tube lack a metal heat fin. Methods include using an evacuated tube holder and ten evacuated tubes of the same size, each having a copper metal fin and copper heat exchange tube, to test a range of insulating materials with varying R values: fiberglass, sand, soil, pine straw, and gravel. Another method is wrapping the fiberglass insulation around the heat exchange tube so that insertion and removal of both the heat exchange tube and fiberglass is easier. The data illustrates that indoor trials consistently surpassed 100 degrees Fahrenheit using two flood lamps; however, indoor trials will work to determine if an insulation is better or worse than the other insulations. In the future, data collection using the above mentioned materials will be completed.

### MODULATION OF LYMPHOMA CELL SURVIVAL AND ANTIGEN PRESENTATION BY INORGANIC ARSENIC

Maegan Albert  
Governor's School for Science & Mathematics  
Mentor: Azizul Haque, Medical University of South Carolina

Inorganic arsenic is a known carcinogen and a widespread water pollutant. Humans exposed to arsenic through drinking water are prone to develop malignancies such as skin cancer, lung cancer, colon cancer and bladder cancer, but rarely develop B-cell lymphomas. Modification of B-cell lymphoma antigen presentation by the arsenic may contribute to this trend of

lymphoma resistance. In this study, B-cell lymphoma was treated with arsenic and its antigen presentation to T-cells was measured. Arsenic's potential as an immunotherapeutic treatment was studied by observing whether it can kill lymphoma cells at high concentrations while enhancing immune responses at sublethal doses. Preliminary results are promising, showing lymphoma cell death and an increase in immune cell response.

#### THE EFFECT OF DIFFERENT LIGHT CONDITIONS ON *CHLORELLA* SP. GROWTH AND LIPID PRODUCTION

Kaouri Marie Alipio  
Spring Valley High School

The need for fossil fuels in transportation usage has exhausted the fossil fuel supply and increased the demand for it or need for change in the types of fuel used in transportation. The most effective solution would be to use algae biofuels. This research was aimed to find the best strain of *Chlorella spirulina* for biofuels. The research was to cultivate the *Chlorella* sp. under different light conditions to determine if the different light conditions would increase lipid growth in the algae. It was hypothesized that the *Chlorella* sp. grown under the yellow light filters would produce more algae and produce the most lipids needed to make biofuels. The *Chlorella* sp. was placed under a grow light where they were separated into four different light filter groups, no filter, yellow, orange, and blue filter. The *Chlorella* Sp. was grown for 2 ½ weeks. Energy yield of the algae was measured using a calorimeter and the amount of energy present in the algae was determined by calculating temperature differences, final temp- initial temp, and results showed that there was no significant difference ( $F(3,20)=1.37$ ,  $p=0.280$ ) in the algae grown in different light filters. Therefore, the hypothesis was not supported. In conclusion, the impact of yellow light on lipid growth and overall growth is no greater than the impact of other types of lights such as orange light and white light.

#### EPIGENETIC CHANGE EFFECTS ON DIFFERENTIATED EMBRYONIC STEM CELLS *IN VITRO* AND *IN VIVO* IN MICE

Julia Altman  
Governor's School for Science & Mathematics  
Mentor: Ting Wang, Washington University School of Medicine

Epigenetics determine gene expression. Learning more about the effects of epigenetics could lead to a new treatment method for genetic illnesses. This study shows whether similar epigenetic changes occur when neural stem cells differentiate in culture or in vivo. Differences in gene expression between the two samples could be the result of varied epigenomes. The study aims to shed light on the differences between the epigenetics of stem cells differentiated in vitro and in vivo in order to better understand the limitations of lab grown cultures. Oligodendrocytes, astrocytes, and motor neurons were successfully differentiated using growth factors and then sorted using fluorescence activated cell sorting (FACS). Samples were taken from live mice for comparison to cultured cells. These cells were verified and primers were identified to aid in determining the relative expression of genes in vitro versus in vivo. Some of the qPCR results were unexpected, however, we were successful in isolating the desired cell types through FACS. Future studies will further examine the impact that in vitro differentiation has on the gene expression of the cells. Understanding this could lead to a better understanding of the differences of samples in vitro and in vivo.

#### WHAT IS THE RELATION BETWEEN SCHOOL DIVISION AND THE AMOUNT OF BACTERIA IN EVERYDAY PLACES

Olivia Antonetti, Olivia Merritt, and Kit Mullins  
Heathwood Hall

The purpose of this project was to find the relationship between school divisions and the amount of bacteria in everyday places. The tested locations were 1) water fountain buttons, 2) doorknobs, 3) computer keyboards, 4) desks, and 5) bathroom sink faucets. In order to find the amount of bacteria in each place, a cotton swab was swabbed on each location. The contaminated cotton swab was then placed on the petri dish using aseptic technique. Each petri dish already contained agar, that had been made and poured twenty-four hours beforehand. The hypothesis for this study states that if the amount of bacteria is compared between school divisions, then there will be a relationship between the amount of bacteria and school divisions. If there is a relation between school divisions and the amount of bacteria, then the lower school division will contain the most bacteria. The null hypothesis states that there will be no relationship between school divisions and the amount of bacteria. This experiment will benefit other schools because they will learn which division needs to be cleaned with more attention. Surprisingly, our results did not support our hypothesis, because the middle school showed the greatest amount of bacteria, when it was hypothesized the lower school would.

#### COMPARING DIFFERENT METHODS OF OBTAINING GRAPHENE FROM GRAPHITE

Hosam Arammash  
Spring Valley High School  
Mentor: Changyong Qin, Benedict College

Over the past couple of months intensive research has been carried out to try to determine a cost effective, efficient, and reliable method of producing graphene from graphite. The benefits of graphene are endless as it can be applied to different fields such as water purification as well as energy production. Fortunately, graphene poses relatively no implications, except one. The biggest problem linked with graphene is the ability to produce it, as graphene is extremely thin. In more scientific

terms graphene is simply one sheet of graphite, which is fairly difficult to obtain. Two methods were conducted to observe whether graphene could be formed, each with its own little twist. Both methods utilized a state of matter known as supercritical fluid (SCF), to help separate the sheets. This state having characteristics of both gases and liquids, was able to make its way between the sheets. However, this method posed issues as after the graphene was released from heavy pressure, the sheets returned together. The second method hoped to solve this issue by adding a solvent, Dimethylformamide (DMF), to try to strengthen the bonds separating the sheets. As an extra precaution the sheets were then submersed in liquid nitrogen, further strengthening the bonds separating the sheets. The hypothesis of the experiment was that the second method would have higher results, as more was put into it. After conducting the research this was in fact true, with the second method producing substantially higher quantities of graphene than the first.

#### PROCESSING OF MISCIBLE THERMOSET BLEND WITH IMPROVED MECHANICAL AND WEAR BEHAVIOR

Saulo Arias Hernández

Governor's School for Science & Mathematics

Mentor: Srikanth Pilla, Clemson University International Center for Automotive Research

The automotive sector is subjected to the regularly-revised Corporate Average Fuel Economy (CAFE) standards for improving average fuel economy and vehicular efficiency of cars and trucks produced in the United States. This has led to focus on reducing vehicular weight. A 10% reduction in weight has led to savings of 7-8% in fuel consumption. Currently used gears and sliding components in automobiles are produced from ceramics due to their excellent high-temperature properties and strong velocity resistance. However, ceramics also suffer from the drawback of high weight due to densities above 5g/cm<sup>3</sup>. Existing polymers can address this issue, but suffer from rapid deterioration, making them susceptible to wear. Hence, the need exists to develop polymers having the same heat, velocity, and wear resistance, durability, low density, and similar properties to those possessed by ceramics. This work presents an alternative solution in the form of wear-resistant polymers prepared using blends of two components to obtain optimal wear properties with enhanced mechanical performance for manufacturing these components. It is expected that through their integration, wear-resistant polymers will contribute towards significant reduction in vehicular weight of automobiles and help achieve desired environmental standards by 2025.

#### THE EFFECT OF THE LOVES TRUCK STOP ON THE TEMPERATURE, PH, MERCURY, DISSOLVED OXYGEN, AND TURBIDITY ON THE NEARBY WETLANDS

Madeline Ashcraft

Heathwood Hall

The purpose of this project is to determine the effect, if any, a new Loves Truck Stop has on the wetlands near the campus of Heathwood Hall. The temperature, pH, mercury levels, dissolved oxygen, and turbidity of the water was tested before the truck stop opened, as well as after it opened. Ten water samples were taken from the wetlands and each sample was tested for the aforementioned data. After the truck stop opened, ten more samples were taken from the wetlands and tested again. The results show that the truck stop has slightly negatively affected the quality of the water in the wetlands. These results support my hypothesis.

#### THE EFFECTS OF DIFFERING PROMOTIONAL METHODS ON RECYCLING BEHAVIOR

Moji Awe

Spring Valley High School

Recycling is beneficial to the environment by reducing waste entering landfills. Many people have the ability to recycle, but it may become difficult if the members of the community do not have a basic understanding of recycling guidelines. The purpose of this experiment was to determine which method of promotion would have the greatest influence on the number of correct items recycled. It was hypothesized that the group in which the recycling bins location was manipulated to a more prominent location would be the most effective in increasing positive recycling behavior. The experiment was conducted at a public high school, where a randomly selected number of classrooms were chosen to participate. The different advertising methods were a flyer (Group A), a video (Group B), manipulating the location of the recycling bins (Group C), and the control group (Group D). A total of three classrooms were selected for each of the groups. The items in the recycling bins were analyzed twice before the promotions and once after. The results from the items recorded before and after the promotions were analyzed. A paired samples t-test was performed and showed that neither Group A ( $t(6) = 1.36, p = 0.223 < 0.05$ ), Group B ( $t(2) = 0.00, p = 1.00 < 0.05$ ), Group C ( $t(5) = 2.28, p = < 0.05$ ), nor Group D ( $t(4) = 1.07, p = 0.346 < 0.05$ ) presented a statistically significant difference in the correct items recycled before and after the promotions. Thus, it was not able to be determined which method of advertisement was most effective in influencing positive recycling behavior.

## THE EFFECT OF THE BICYCLE SAFETY DEVICE ON HOW FAR AWAY A CYCLIST CAN DETECT A CAR BEHIND THEM.

Evan Barker, Luke Gabel, and DuBose Tuller  
Heathwood Hall

The purpose of this study was to determine the effect of a device called the Bicycle Safety Device (BSD) and the use of headphones on how far away a cyclist can detect a car behind them. Research was done on the topic of bicycle safety because road biking can be very dangerous at times. Studies show that most bicycle related accidents happen due to the driver not seeing the cyclist or the cyclist not knowing of the driver. The Bicycle Safety Device aims to prevent that problem by alerting the cyclist. This will then allow for the cyclist to avoid the driver. The Bicycle Safety Device or BSD is an object sensor that alerts the cyclist, with a loud beep and flash of light, when a car gets close. The BSD was tested in multiple environments including the cyclist wearing headphones. Testing the BSD involved going onto a long straight road and having a car randomly approach the cyclist. The cyclist would then stand up if the BSD noticed the car. The headphones had a major effect on the cyclist, The car sometimes even passed them. The BSD was successful in many situations presented, but did not statistically increase cyclist's detection of the vehicle.

## THE EFFECT DIFFERENT FLAVORS OF ICE CREAM HAVE ON THEIR MELTING RATE

Mary Martha Beard and Julia Faulds  
Heathwood Hall

The purpose of this project was to test the effects that the flavor of Southern Home ice cream had on the rate of which it melts. To conduct this experiment, a tablespoon of each flavor of ice cream was placed into a funnel into a graduated cylinder that collected the volume of ice cream melted. Ten samples for each flavor were placed in an incubator set at 50° Celsius for 10 minutes. After testing this procedure for vanilla, chocolate, and strawberry ice cream, the data displayed that the ice cream melted in descending order of strawberry, chocolate, and vanilla. In conclusion strawberry ice cream melted the slowest, followed by chocolate ice cream, and vanilla ice cream, due to the content of strawberry chunks, which caused the ice cream to melt significantly slower than chocolate and vanilla. The chocolate ice cream melted slower than vanilla due to the cocoa powder and higher fat content. Vanilla melted the quickest because it had a lower fat content and a higher water content which causes ice cream to melt quicker.

## WHAT FEATURES OF A NEWS POST ON SOCIAL MEDIA MAKE IT SEEM CREDIBLE?

Clayton Bellinger  
Chapin High School

Fake news is becoming a very prominent issue in today's internet based society. These sites generate ad revenue in the tens of thousands of dollars, and there are hundreds of active sites that distribute false stories. This project aims to distinguish certain features of a news post on social media that people find to give it credibility. Of the most popular Facebook posts in 2016 on Zika, 6% were misleading, and one of the most prominent misleading posts was shared over 500,000 times, demonstrating the range of this issue. Illuminating specific features of a post that draw people's eyes will help expose the superficiality of many features of media posts in today's digital society. Preliminary data shows that pictures included in a news post will be most effective in contributing to credibility.

## THE EFFECT OF ULTRAVIOLET RADIATION ON THE GROWTH OF THE PHYTOPLANKTON *AMPHIDINIUM*

Pranav Bellukutty  
Spring Valley High School

The ozone layer has been been depleting over the past few decades, which causes an increase in UV radiation that threatens growth and survival for phytoplankton. This issue has been researched thoroughly, and the effect of ozone depletion on the phytoplankton is enormous, as an increase in UV rays makes it more difficult for phytoplankton to grow. The purpose of this experiment was to compare the effects of ultraviolet light and white light on the growth of the dinoflagellate *Amphidinium*. As the ozone hole progressively gets larger, the amount of ultraviolet radiation the phytoplankton are exposed to will continue to increase. Since *Amphidinium* lives at the surface of oceans and lakes, it will be more readily affected by this. It was hypothesised that if the *Amphidinium* were exposed to ultraviolet radiation, then they would grow less in comparison to the *Amphidinium* exposed to the white light because the UV light will disrupt the *Amphidinium*. *Amphidinium* cultures were placed under the white light for 1 week before being split into two groups of 15 each, one exposed to UV and the other to white light. The separate treatments continued under their respective lights for another week. Afterwards, the wavelengths (nm) were calculated. The results showed that the white light had a smaller mean of 34.971 nm while the UV light's mean was 42.091 nm. A T-test determined the values were insignificant, as  $P > \alpha(T(68) = -2.01 \quad p = 0.072)$ . The hypothesis was not supported because the test yielded insignificant results.

## CLONING OF LPAR2 VARIANT (CHEST973J21) FOR FUNCTIONAL ANALYSIS

Claire Benson

Governor's School for Science & Mathematics

Mentor: Eric Birgbauer, Winthrop University

Lysophosphatidic Acid (LPA) is a phospholipid derivative that is involved in several biological activities, including acting as a signaling molecule. LPA has been previously observed to cause specific, dose-dependent cone collapse of retinal neurons in chick embryonic retinal axons. LPA is expressed in various cell and tissue types. Several studies also tie LPA to human cancer, various diseases, disorders, and infertility. The LPA receptor LPA2 is encoded by the LPAR2 gene, which is expressed in several organs including the prostate, spleen, pancreas, and ovary. Recently, a chicken cDNA clone, ChEST973j21 (ChEST), was observed to be partially identical to LPAR2 at the nucleotide level, so it was considered an LPAR2 variant. It is important to understand the biological functions of ChEST in relation to cellular signaling and response. In order to do this, ChEST and chicken LPAR2 were cloned into mammalian expression vectors so they could ultimately be expressed in B103 cells to assess ChEST function. By determining the functions of ChEST, it can be compared to the cellular responses and interactions of chicken LPAR2. This will help determine whether ChEST is a new LPA receptor that responds to LPA. In order to determine this, successful ligation must first be obtained. Therefore, it is important to understand how to achieve successful ligation. Several modifications have been made to the protocol to try and obtain successful ligation. However, ligation was never successful, but amplification of the ChEST gene and expression vector were.

## PARENTAL BASIS FOR HPV VACCINATION REFUSAL

Sydney Bertram

Center for Advanced Technical Studies

Despite many efforts to increase the HPV vaccination rate, vaccination coverage rates remain low among both male and female adolescents. The purpose of this experiment is to discover and compare the reasons that parents of boys and parents of girls decline the HPV vaccine for their children. A written survey was given to parents who declined the HPV vaccination for their child during a visit to one of several Columbia-area pediatric offices. Parents anonymously answered questions about their demographics, used a Likert Scale to indicate their agreement with possible reasons for declining the vaccine, and ranked their top three reasons for declining the vaccine. At the time of this writing, no data has yet been collected. Response differences between parents of each sex will be determined using a Mann-Whitney U Test. It is expected that parents of boys and parents of girls will have statistically significant differences in their reasons for declining the HPV vaccination. This new data will provide insight to health practitioners on how to most effectively educate parents in order to increase the HPV vaccination coverage rate. If parents of boys and parents of girls do have different reasons for declining the HPV vaccine, practitioners may want to approach each group differently.

## CHALLENGES FACED BY CYBER SECURITY ASSETS IN THE UNIVERSITY OF SOUTH CAROLINA

Matthew Beymer and Hensley Graycen

Governor's School for Science & Mathematics

Mentor: Chad Hardaway, University of South Carolina Columbia

Cyber security assets are threatened more and more every day. Researchers at the University of South Carolina examined the University's existing cyber security practices and considered changes that might afford better protection. This paper presents the results of interviews with faculty conducting research in several fields. An interview script was created and responses from the interviews allowed the authors to determine several trends in cyber security challenges. Comparisons of these trends as they relate to research by different faculty show that parallels exist which may allow for improvements regarding cyber security across the university and eventually the state.

## THE EFFECT OF A MOBILE APPLICATION ON FIRE SAFETY EDUCATION

Elizabeth Bickel

Spring Valley High School

The lack of knowledge about fire safety is a growing concern in our country. The National Fire Protection Agency surveys have shown that about 75% of Americans claim to have a home evacuation plan. However, more than half of those families cannot attest to practicing by means of a home fire drill. To better inform families of this important issue, the implementation of a fire safety application is proposed. This research was aimed at the creation of a mobile application to aid families in forming a fire escape plan, and informing them of the dangers of house fires, and focused on the creation of the first "Flash cards" section. It was hypothesized that the in-app flash cards would prove more beneficial in helping students to learn than traditional paper flash cards. The app was first developed through Apple's XCode platform. Students were then tested with the digital flashcards and paper flashcards to see which was more effective. A two-sample t-test showed that the difference in quiz scores between the control group ( $n = 15$ ,  $M = 1.40$ ,  $SD = 1.12$ ) and the experimental group ( $n = 15$ ,  $M = 0.8$ ,  $SD = 1.37$ ) were not statistically significant,  $t(6) = -1.31$ ,  $p = 0.89$ . This concludes that the null hypothesis is supported, and it is suggested that there was no significant difference between the use of the app and the cards.

## THE COMPARISON OF VARYING MUSIC GENRES ON CONCENTRATION WITH ADOLESCENTS

Addison Blackmon  
Chapin High School

In 2015, 7.7 percent of high school seniors used amphetamines, among the most-used prescription, over-the-counter or illicit drugs, according to a survey sponsored by the National Institutes of Health. It is hypothesized that instead of using harmful drugs to enhance focus, music could be used as a replacement. Music causes the brain to release dopamine, which relaxes the individual and makes them more receptive to information. Researchers have found that music activates brain regions that are involved in movement, attention, and memory. The purpose of the project is to answer the question: "Which music genre is most effective in enhancing focus with adolescents in High School?" which will be answered through the use of survey and word searches. The students will answer questions on a preliminary survey, and then will be given word searches to complete under different music environments. The hypothesis is that classical music will be the most successful in strengthening focus because of past research supporting the hypothesis. The data from the survey showed there is a 0.702863 correlation between responses and certain questions. It is predicted that with further data collection, a more significant conclusion will be made on which music genre will help adolescents focus better.

## THE EFFECT OF CORTICOSTEROIDS AND ANTIHISTAMINES ON THE GROWTH RATE OF THE FUNGUS

*ALTERNARIA ALTERNATA*

Erin Blalock  
Spring Valley High School

The fungus *Alternaria alternata* is an allergy-causing fungus. Studies have shown that there is a positive correlation between the presence of asthma and allergies and exposure to the *Alternaria alternata fungus* (Salo *et al.*). The purpose of this experiment was to investigate whether or not drugs commonly used to treat an allergic reaction caused by the fungus, have any effect on the growth of the fungus *Alternaria alternata*. Since corticosteroids repair the epithelial barrier and antihistamines sooth irritated histamine receptor, both treating the reactions caused by the fungus, it was hypothesized that one of these drugs would also have a an effect on the growth rate of the fungus. In the conducted experiment, the growth rate of the fungus *Alternaria alternata*, was recorded after applying Albuterol Sulfate, a corticosteroid measurement of 0.833 mL, and Diphenhydramine, an antihistamine measurement of 1 mL to the fungus. The growth rate was calculated by finding the difference between two specific diameters and dividing it by t or the amount of time elapsed between these measurements. While, the descriptive statistics illustrate that, the growth rate of values when the Diphenhydramine was applied after 24.17 hours had the most significant decrease in median growth rate, with a median value of -0.35003 mm/hour, the statistical analysis suggested there was no difference in the means. A One-Way ANOVA showed that the mean growth rates for all applications were not statistically different, as the  $p = 0.0935 \geq 0.05$ , since  $F(5,174) = 1.92$ . The results of this study showed that corticosteroids and antihistamines did not have an effect on the growth rate of the fungus.

## USING ULTRASONIC WAVES TO DETERMINE BOND QUALITY BETWEEN ALUMINUM PLATES

Chris Bodkin  
Governor's School for Science & Mathematics  
Mentor: Lingyu Yu, University of South Carolina Columbia

Structural health monitoring (SHM) addresses a pressing need of our aging infrastructure. The increasing costs of maintaining the aging infrastructure can be addressed through SHM systems that will decrease unscheduled maintenances while increasing safety and reliability. A more specific area of concern is in the aerospace industry. Most aircraft are made with a large amount of composites, which have unique damage types such as micro-cracking and delamination. These damages can cost an excess of money and lives if not detected early. This experiment was made to learn if non-contact SHM could be used to determine bond quality. This is important because layered composites are thin layers of different materials that are bonded together. In this experiment, aluminum plates were bonded together using adhesive film. Multiple pristine specimens were made as well as a damaged specimen, the damaged specimen had a piece of Teflon in the bonding. The plates were taken to an immersion tank to be scanned with ultrasonic waves. The scans were able to show variations in the bonds as well as the damage. This is good news, as further research can be done working toward an efficient and dependable SHM system for the aerospace industry.

## IDENTIFYING MARKERS OF STEM CELL DIFFERENTIATION THROUGH QPCR QUANTIFICATION

Abbie Bowman  
Governor's School for Science & Mathematics  
Mentor: Ting Wang, Washington University School of Medicine

Stem cells provide the answers to all biological questions. These undifferentiated stem cells turn into specialized cells through growth factors and other signaling molecules. In clinical application, stem cells can be designed for specific treatments to treat illnesses and diseases. However, the way in which stem cells differentiate is still unknown. We know that growth factors can turn on certain signals and push a stem cell toward a certain fate but, we do not know which signaling molecules are used. The changing of gene expression through modifications to chromatin structure is known as epigenetics. The understanding of how epigenetics work in differentiated cells would allow researchers to delve deeper and answer the questions no one knows. However, to study the epigenetics of a differentiated cell, one must be able to confirm the identity of a differentiated stem cell.

We developed methods to confirm differentiated cell types. Using primers designed for specific genes in Astrocyte, Oligodendrocyte, and Motor Neuron cell samples, we ran qPCR quantification to amplify specific genes in the differentiated neural cell samples. A total of 11 genes were amplified in differentiated cell samples, 8 expressed in Oligodendrocytes, 1 expressed in Motor Neurons, and 1 expressed in Astrocytes. We identified markers of stem cell differentiation which allow the further development of epigenetic exploration.

#### AUTONOMOUS COURSE NAVIGATION BY HIGH-SPEED 1/10 SCALE RACECARS USING LIDAR AND PASSIVE STEREO CAMERA

Nikki Bregman

Governor's School for Science & Mathematics

Mentor: Sertac Karaman, Massachusetts Institute of Technology

The field of autonomous vehicles is rapidly expanding. Companies like Google and Tesla have been on the forefront of these advances. This project aimed to explore the challenges of autonomous vehicles through scale model cars. Our Rapid Autonomous Complex-Environment Competing Ackermann-Steering Robots (RACECARs) were outfitted with a 270° laser radar (LiDAR) and a color stereo camera and ran Ubuntu for ARM processors using the open-source Robot Operating System (ROS) software library. The project was broken into weeks with building goals culminating in the completion of a racecourse. The first goal was to use LiDAR for autonomous wall-following. The second goal was to identify colored flags and turn based on the color, following the correct wall. The next focus was on space exploration and identifying a greater variety of colored flags. Our work shed light on the pitfalls of autonomous navigation and the path that future work will follow.

#### DEVELOPING A HUMAN POWERED ELECTRIC BICYCLE

Christopher Bristow

Center for Advanced Technical Studies

Current electric bicycle kits face a major problem with limited range due to battery type. Development of an electric bicycle kit with a human powered generator will increase the bicycle range by storing energy from the pedaling motion of the operator. In order to make a normal bicycle electric, a hub motor is placed in center of the front wheel. The generator is installed and connected to pedals allowing the energy from pedaling to be stored in batteries extending the conventional electric bicycle range. Based on the project's design, the cyclist will be able to travel farther on a single battery charge. The voltage and amperage are monitored in this research study while pedaling on downward slopes and on flat surfaces. The effectiveness of the generator is then determined and range extension calculated. An electric bicycle kit with a generator will allow the cyclist to travel longer distances between charges and human powered on-board recharging will provide an energy efficient product not currently available in today's market.

#### BREAST CANCER RADIATION BRA

Brogan Brown

Center for Advanced Technical Studies

More than 90% of patients receiving radiation treatment will develop the painful skin reaction Radiation Dermatitis, more commonly known as radiation burns. For women who undergo radiation therapy for breast cancer, radiation dermatitis often renders them unable to wear a traditional bra due to the painful and sensitive nature of their skin. In order for many of these women to carry on with both their treatment plans and their lives, an alternative garment option is needed. Preliminary free response surveys and multiple choice surveys were sent out to a network of patients and survivors to establish criteria and guidelines for what the product should accomplish. Patient and survivor insight, as well as physician recommendations will be utilized in the design and fabrication of the product. After a prototype is made, a review survey will be sent out to a subset of the original network in order to judge the prototype against the established criteria. Data analyses will be run on the review surveys to identify weak aspects of the product design. Prototype fabrication and review will continue until prototype satisfies all criteria. Ultimately, the breast cancer radiation replacement bra will allow women undergoing radiation treatment for their breast cancer to continue on with both their treatment plan and their lives, no longer hindered by pain or the inability to wear an undergarment.

#### EXPANSION OF A HELMET'S EFFECTIVE DENSITY EFFECT ON AMOUNT OF LINEAR ACCELERATION EXPERIENCED INTERNALLY

Davis Buchanan

Heathwood Hall

The impulse of two objects is always conserved in an impact, however this does not mean that all of the impulse must be felt or experienced by a partaking internal figure. During any given football practice or game, concussion is a possibility, as players often exchange blows to the head and neck area, whether legal or not. Forty-seven percent of the three and a half million concussions reported in 2015 occurred during high-school football, according to Headcase ([www.headcasecompany.com](http://www.headcasecompany.com)). Modern helmets are simply insufficient in protecting the brain against concussion. Greater public awareness about the risk and consequences of concussion, as well as better understanding of concussion's long-term effects has shined new light on the topic recently. By increasing a helmet's padding effective density (thickness), you allow for

more time between the initial external collision of the helmets, and the acceleration of the brain internally which leads to concussion. The time increase between the internal and external accelerations, should allow for lesser peak accelerations felt by the brain, according to the formula: change in time equals mass times change in velocity, as a greater time will mean a lesser peak force exerted internally. The null hypothesis, stating that an increase in effective density would not have an effect on accelerations internally was not able to be rejected, because an ANOVA test of the data showed no statistical difference; however, a bar graph of the different means did suggest that there is possibly a correlation.

#### TEMPORAL RELEASE DYNAMICS OF VARIOUS TEMPERATURE SENSITIVE LIPOSOME FORMULATION

Katrina Bynum

Governor's School for Science & Mathematics

Mentor: Dieter Haemmerich, Medical University of South Carolina

Drug delivery systems have been developed to target tumors and decrease toxicity and side effects associated with chemotherapy. Temperature Sensitive Liposomes (TSLs) are a type of nanoparticle (100-200 nm) that can act as a drug delivery system. TSLs contain a drug and release it at hyperthermic temperatures (>40°C), and, with localized hyperthermia, can release its contents directly to a tumor site. Blood stays at a tumor site for only a few seconds, so the drug must be released quickly in order to be most effective. Therefore, it's important to test and characterize various conditions for drug release from TSLs in order to find conditions that allow for the greatest drug release in the shortest time period. In this experiment, a novel setup was created to study release dynamics of doxorubicin (DOX) under varying conditions: temperature, liposome formulation, and the solution in which DOX is released. TSL-DOX was pumped through a thin capillary tube set above a Peltier element, allowing rapid heating and thereby releasing DOX from TSL. DOX fluorescence is quenched inside TSL, but once released, DOX can fluoresce and its concentration can be measured. The Peltier element was heated to temperatures ranging from 37°C to 45°C in 1°C intervals. Three formulations were tested (citrate buffer, ammonium sulfate buffer, and commercial Thermodox) in two different solutions (phosphate buffered saline and fetal bovine serum). The citrate buffer formulation of TSL-DOX had the greatest and quickest DOX-release at 45°C in FBS, at 80% DOX release within 1.5 seconds.

#### EXPLORING VIRTUAL BRANCHING STORIES FOR VR HEADSET GAMING USING UNITY ASSETS AND C# SCRIPTS

Brennora Cameron

Governor's School for Science & Mathematics

Mentor: William Bares, College of Charleston

Interactive narrative experiences within virtual reality allow players to make choices that control how the plot unfolds. Players have the freedom to truly embrace and walk around a virtual 3D world. These interactive experiences have become a hot topic in today's society. People enjoy this technology, but many gamers have brutally critiqued the flatness of these games. In games such as Job Simulator, there is no power in the hands of the player; the user may get the sense that they are being tugged along the game's predefined plot line. Among the gamer community, there is an overall desire for a game that will let the player control the story. Because of this, many questions are raised. This summer, the College of Charleston Department of Computer Science under the direction of Dr. William Bares created a narrative-driven game, set in a virtual realm. The objective of this project was to create a game where the player is allowed to control their own gaming experience and will want to play it again. This game is meant to incorporate meaningful dialog decisions and 3D interactions through the use of Unity dialogue trees. Due to the game's branching decision structure, there are several ways to reach a multitude of endings.

#### EFFECTS OF LONG-TERM LIF EXPOSURE ON MYOTUBE DIAMETER AND PROTEIN SYNTHESIS

Pierce Carrouth

Governor's School for Science & Mathematics

Mentor: James Carson, University of South Carolina Columbia

Cachexia is a muscle wasting syndrome found in patients with late stages of cancer. It leads to rapid loss of body fat and skeletal muscle tissue and has a significant impact on the mortality rates of patients. Cachexia is multifactorial, but studies have shown that high levels of inflammatory cytokines such as IL-6 and LIF induce symptoms that promote this muscle wasting. However, it is unknown whether this is from an overexpression of protein synthesis or an increased protein degradation. LIF is a cytokine in the IL-6 family, and its impact on cachexia needed to be measured. C2C12 cells were treated with LIF for 24 hours prior to collection and the rates of myotube atrophy and protein synthesis were measured in order to determine the role of LIF on cachexia. Myotubes were photographed and the average diameters of the groups grown with LIF and without LIF were calculated. Puromycin, which was introduced to the cell cultures 30 minutes prior to collection, and p6070SK content was measured for the control and experimental groups using a western blot. Cell groups that were introduced to LIF had smaller myotube diameter and were less organized than the control group. Cell groups with LIF had significantly lower amounts of puromycin and p6070SK in their cells. Based upon these results, LIF induces symptoms myotube atrophy symptoms, as well as the rate of protein synthesis. However, further research is required to understand LIF's signaling pathways and the affect other cytokines have on cachexia.

## ENHANCING THE BIOMECHANICAL DESIGN OF THE FOOTBALL HELMET (CONCUSSION PREVENTION) PT. 2

Casey Carter

Spring Valley High School

Mentor: Abigail Tyson, Virginia Tech University

Concussion research has become a very relevant topic across various media outlets. In the NFL there was an increase of 58% on the amount of concussions during the regular season in 2016. Concussions are very serious injuries to the brain and there needs to be as much data as possible to continue preventing their occurrence. The purpose of this continued research study was to seek a solution that would help with the prevention of concussions in the sport of football. The hypothesis stated that, If there was an attachment added to cover the brain-stem area of the football helmet, then there would be a decrease in the kinetic energy measured. To test this theory a Pendulum Impact Machine was used in the Impact Biomechanics Lab at Virginia Tech University to replicate the force of impact and measure the outcomes. The prototype was placed at the brain stem area of the football helmet and is used to protect the skull by distribute force that could lead to concussions. Impact was conducted on the front, back, and side of the helmet, with and without the created prototype. The resultants that were reviewed were Peak Angular Acceleration, Peak Angular Velocity and Peak Linear Acceleration. Findings display that, the data partially supported that the prototype has the ability to distribute/lessen the force on the football helmet.

## EVALUATING THE IMPACT OF PUBLIC ART IN CULTURAL DISTRICTS: RESULTS OF A SURVEY IN THE CONGAREE-VISTA

Wells Carter

Governor's School for Science & Mathematics

Mentor: Lee Snelgrove, One Columbia

This research examines which factors best define a cultural district and then attempts to derive a new metric, defined by public art, to measure the impact of the Congaree-Vista in Columbia, South Carolina. A survey instrument was designed. It solicited enough information concerning citizens opinions of public art and cultural districts. The survey was distributed to concerning members of the Congaree-Vista neighborhood association. The data revealed public art has a strong effect on the impact of a cultural district on a community. The evidence suggests that it may be appropriate to use public art as one metric to distinguish a cultural district.

## QUANTIFYING THE EFFECT OF CATIONS ON TRIPLET EXCITED STATES IN G-QUADRUPLEXES IN HUMAN TELOMERIC DNA

Anish Chaluvadi

Governor's School for Science & Mathematics

Mentor: Soo Yong Kim, Korea Advanced Institute of Science and Technology

Today, G-quadruplexes are an active research area because of their potential as an anticancer method. Using fluorescence correlation spectroscopy (FCS), the aim of this research was to prove that different cations could produce different G-quadruplex structures, and this was quantified by measuring the stability of the affected G-quadruplexes through the dynamics of triplet excited states. Being an abnormal intermediate energy level, a G-quadruplex in which electrons go into the triplet state equates to the fact that these G-quadruplexes are less stable, and thus, they are less effective in protecting against mutations and cancer. In this experiment, human telomeric single-stranded DNA was tagged with carboxytetramethylrhodamine, a fluorophore, to quantify the dynamics of triplet excited states. From our data, we concluded that  $K^+$  did not affect the number of photons in triplet excited state whereas the number of photons in triplet excited states in  $Na^+$ -based and  $Mg^{2+}$ -based G-quadruplexes decreased with greater concentration. From this, it was reasonably hypothesized that different cations resulted in different loops around G-quadruplex structures. Specifically,  $Mg^{2+}$  would produce the most safe and stable G-quadruplex structure because it decreased the percentage of electrons in the triplet excited state by a wide margin. This experiment could be foundational in opening a new pathway for targeted cancer research, proving that the structure and shape of G-quadruplexes could be manipulated through a variety of mechanisms.

## AN ANALYSIS OF THE EDUCATIONAL POTENTIAL OF THE BIG SHORT

Ethan Chan

Governor's School for Science & Mathematics

Mentor: Jim Morris, SC Economics

The general public is relatively unaware of certain details within the science of economics. Economics covers a very large range of topics that is often very difficult to understand. The film *The Big Short* offers a solution. It is about the housing crisis of 2008. It is meant to be educational and easy to follow such that the average viewer can understand the economic concepts portrayed in the film. The film's success at educating its audience was tested. The results showed that for the particular subject group, the film accomplished its goal. Viewers were able to learn about the housing bubble and how it burst. They learned several economic concepts discussed in the film. The subjects gave positive feedback on the movie. Films are a great method for teaching because they appeal to such a large audience. Many people already watch films, so it is beneficial for them to be learning as they do it. People are more likely to see a film than sit in a lecture to learn about a topic. The success of *The Big Short* may inspire films in the future to follow its example.

## NOVEL MOSQUITO CONTROL: A NATURAL APPROACH TO REDUCING AND REPELLING MOSQUITO POPULATIONS

Vinita Cheepurupalli  
Spring Valley High School

Mosquitoes are considered one of the most dangerous animals around the world, causing over 725,000 deaths globally per year. They are a major concern to human health because they can serve as vectors to pass agents that cause diseases, such as malaria, yellow fever, the Zika virus, and the West Nile virus, among many others. While many of these diseases can be cured, they can cause a multitude of harmful side effects, such as seizures, coma, conjunctivitis, and death. Different commercial mosquitocidal agents exist, but the overuse of them have caused mosquitoes to develop resistance, as well as causing harm to humans and the environment. To help prevent resistance, natural extracts could be used to repel or kill mosquitoes. The purpose of this experiment is to test various plant extracts for their effectiveness in acting as larvicides, insecticides, and repellents against *Culex quinquefasciatus*. It was hypothesized that if *Chrysanthemum coccineum* (chrysanthemums), *Trachyspermum ammi* (ajwain), and *Nymphaea odorata* (white water lily) were tested as natural insecticides, larvicides, and repellents, and VectoBac 12AS, permethrin, and DEET were tested as commercial mosquitocides and repellents, VectoBac 12AS, DEET, and permethrin would be the most effective as larvicides, repellents, and insecticides, respectively. *T. ammi* would be the most naturally effective larvicide, insecticide and repellent, followed by *C. coccineum* and *N. odorata*. For the purpose of this experiment, the essential oils from the leaves of *Chrysanthemum coccineum*, *Trachyspermum ammi*, and *Nymphaea odorata* were extracted through steam distillation; these oils served as the natural treatments. *Culex quinquefasciatus* were used as the model mosquito. To test the larvicides, 20 L4 larvae were placed in 10 mL of water, and 1  $\mu$ L of the extract was added to the water. Mortality was observed. To test the insecticides, 250 mL bottles were coated with a stock solution of ethanol and the extract. Mosquitoes were introduced to the bottles and the mortality was observed. To test the repellents, mosquitoes were introduced to a tube with filter paper on one end and filter paper soaked in an extract on the other end. Movement of the mosquitoes was observed. For the larvicide and insecticide data, repeated measures ANOVAs were conducted, and since  $p < 0.001$ , it was concluded for both that there was a significant difference in the data ( $F(10,1085)=18.21$ ,  $F(4,1085)=75.70$ ,  $p < 0.001$ ,  $F(10,1085)=18.44$ ,  $F(4,1085)=76.83$ ,  $p < 0.001$ ). Interaction plots showed there was no correlation between time and treatment. One way ANOVAs showed that there was a significant difference between treatments ( $F(4,95)=15.34$ ,  $p < 0.001$ ,  $F(4,95)=19.61$ ,  $p < 0.001$ ). Post-hoc Tukey tests found that there was a significant difference in mortality ajwain and chrysanthemum, ajwain and lily, ajwain and control, chrysanthemum and permethrin, lily and permethrin, the control and permethrin, chrysanthemum and VectoBac 12AS, lily and VectoBac 12AS, and the control and VectoBac 12AS. For the repellent, a one way ANOVA conducted found that there was a significant difference between 2 or more of the treatments ( $F(4,95)=4.65$ ,  $p=0.002$ ). A post-hoc Tukey test showed that there was a significant difference between the ajwain and control, chrysanthemum and control, lily and control, and DEET and control. Thus, the hypothesis was partially supported as VectoBac 12AS, DEET, permethrin, and ajwain were the most effective as larvicides, insecticides, and repellents, but *C. coccineum* was less effective than *N. odorata*. Ajwain would be an effective larvicide, insecticide, and repellent, while the chrysanthemum and lily would be effective repellents, and if they were refined, could be used commercially.

## THE EFFECT OF STROMAL CELLS ON TUMOR CELL GROWTH UNDER HYPOXIA

Eric Chen

Dutch Fork High School

Mentor: Peisheng Xu, University of South Carolina Columbia

Tumorigenesis has been considered to be as a result of abnormal cell-cell communication. Although it is known that the tumor-associated microenvironment often becomes hypoxic, how stromal cells influence tumor cell growth in this microenvironment is largely unknown. In this study, we found that under hypoxia, tumor cells survive better when cocultured with their associated fibroblasts than when cultured alone. Fibroblasts, on the other hand, did not undergo noticeable change. This suggests that interactions between the cells significantly affected the tumor cells' ability to withstand hypoxia. Further ELISA array analysis identified several growth factors, including fibroblast growth factor 2 and Granulocyte-colony stimulating factor, which may mediate this interaction. These results suggest that blockage of tumor-stroma interactions by elimination of these mediators may make tumor cells more sensitive to treatments.

## DISASTER-READY KIT

Katie Chin

Center for Advanced Technical Studies

The Philippines has suffered from an inexhaustible number of typhoons, earthquakes, and other natural disasters. The current emergency kits that exist to aid the population during natural disasters lack in cost efficiency and availability. Due to the lack of resources in rural areas, the spread of communicable diseases rapidly occur, targeting areas that are strongly impoverished. The top 6 diseases in 2013 (Acute Respiratory Illness, Open wounds, bruises, and burns, High Blood Pressure, Skin Disease, Fever, Acute watery diarrhea) are easily manageable through basic hygiene. The Disaster-Ready kit is modeled based off of those diseases and aims to ultimately be distributed to people who live in rural areas in the Philippines. By doing so, it is expected to see an increase in availability of these basic hygienic resources to people in areas that are unable to avoid the spread of infection during natural disasters. The kit's success will be measured by a survey dispersed anonymously to patients at San Giuseppe Mission and Health Center located in Canlaon City, Philippines and each survey participant will receive a free kit as a result. This survey includes a rating system for each product, questions regarding other possible

products, and family sizes. When the surveys are returned, the ratings will be collected and the kit will be assembled accordingly.

#### ADIPOSE-DERIVED STEM CELLS SUPPRESSING INFLAMMATION IN PANCREATIC STELLATE CELLS TREATED WITH ETHANOL AND CERULEIN

Priya Chokshi

Governor's School for Science & Mathematics

Mentor: Hongjun Wang, Medical University of South Carolina

An inflamed and scarred pancreas is a major characteristic of chronic pancreatitis. No exact cause has been determined, but certain factors, such as heavy drinking and family history, have been shown to play a role in chronic pancreatitis. The purpose of this experiment was to test a stem cell treatment that could suppress symptoms of chronic pancreatitis, such as inflammation and fibrosis (the scarring of the pancreas). In order to model chronic pancreatitis symptoms, pancreatic stellate cells were treated with ethanol and cerulein to induce inflammation and fibrosis. Our hypothesis was that a treatment with adipose-derived stem cells decreases ethanol and cerulein-induced inflammation in pancreatic stellate cells. The expression of four genes (Beta Actin, Tumor Necrosis Factor Alpha, Fibronectin, and Interleukin-6) was monitored in order to test this hypothesis. The expression of each of these four genes plays a significant role in fibrosis and inflammation. Our qPCR results confirm that the expression of these four genes decreased as a result of the treatment of pancreatic stellate cells with adipose-derived stem cells. These results strongly suggest that adipose-derived stem cells could be an effective treatment for chronic pancreatitis.

#### THE EFFECTS OF SOIL CONTENT ON THE DECOMPOSITION OF A NAPKIN

Townsend Christian and Audrey Osborne

Heathwood Hall

The purpose of this experiment was to identify which variables placed in the soil sped up the rate of decomposition of a shredded napkin. The different variables in the soil are lumbricus terrestris, Tenebrio Molitor, banana peel, and then a control with nothing in the soil. The hypothesis for the experiment was having Lumbricus Terrestris in the soil will result in the fastest decomposition of a napkin. Three trials were conducted. The experiment was carried out over a course of five weeks. The containers were weighed and had pictures taken of them everyday. After the data was collected, it was analyzed by a single factor ANOVA statistical and analysis test. The data was not statistically significant from each other, but it showed the mass of each container in each trial had decreased. The overall result proved that the original hypothesis was right. The hypothesis stated that adding lumbricus terrestris to the soil would speed up the rate of decomposition the most. After analyzing the data, it revealed that the lumbricus terrestris, in fact, sped up the rate of decomposition of the napkin the most.

#### CHARACTERIZATION AND LOCALIZATION OF TRAB AND TRAJ THROUGH FLUORESCENCE STUDIES

Timothy Christie

Governor's School for Science & Mathematics

Mentor: Peter Christie, McGovern Medical School, University of Texas Health Science Center at Houston

This study focuses on bacterial conjugation, and more specifically, explores the Type IV Secretion System and the proteins that make up this machine. The goal of this project is to characterize and localize specific proteins involved with the Type IV Secretion System and thus characterize and localize the machine itself. This is accomplished by modifying the KM101 plasmid that codes for the Type IV Secretion System coupled to a marker that codes for a fluorescent protein. When constructed, the fluorescent protein attaches to the protein of interest and is localized by fluorescence microscopy. Our results indicated that the machine was being created and functions normally with, and without, the presence of recipient cells. One interesting result is that there were multiple foci where the fluorescent proteins were located within a cell. This suggests that multiple machines were being created within a single cell. This study furthers knowledge of how cells transfer genetic material, and could be useful in fields such as medicine and disease prevention.

#### OVERCOMING STEREOTYPES THAT HINDER ACADEMIC PERFORMANCE THROUGH PSYCHOLOGICAL PRIMING

Jessica Cole

Chapin High School

This study is focused on the effects psychological priming has on low to average performing high school sophomores and juniors, in regards to their SAT scores. The brain is constantly receiving stimuli and utilizes memories to correctly respond to the situation at hand. Thus, the environment and the information it yields directly or indirectly affects a person's mindset at a subconscious level. This is known as psychological priming. Prior studies have found that the subconscious can often control not only one's mood, but also one's actions and thoughts. This study builds upon a foundation of research focused on both student-impacting stereotypes (Steele) and studies that focused on motivation (Dweck). The data concluded that there is a significant correlation between presenting students with a fact-based article that iterates the power of the human brain and higher scores on mock passages from the SAT. This project is specifically focused on student population with a high composition of minority. When the psychological priming was applied to students where race-based stereotypes were

activated, they performed better than the control group where the negative stereotypes were not activated. This was proven by a p-value of .07.

#### DESIGNING AN ATTACHABLE ACCESSORY TABLE FOR WHEELCHAIRS

Sam Coleman

Center for Advanced Technical Studies

As more Americans become wheelchair dependent, they are hesitant to lean forward to perform daily activities such as reading or eating. If a table is created to be attached to the wheelchair, then people who are wheelchair bound will be able to perform activities such as reading and eating without having to lean forward because the table will always be there for them. Results will be collected via a survey which will be given to anybody who test the table. This chart has the categories of: usefulness based on size, if the table can be stored beside the wheelchair, how easily the table can be adjusted to meet the requirements of the patient, and if the table is sturdy enough to perform daily tasks. Data will be analyzed based on the feedback from the survey and on criteria which includes: sturdiness, usability, easily stored, and adjustable. Our finding will tell us if creating a table that can be stored beside a wheelchair and then turned up with a motor is actually possible and if there needs to be any modifications to our project. In the future, we hope that this table will lead to us getting a patent on the table which will hopefully allow us to produce this table for the growing number of people who are becoming wheelchair bound.

#### THE EFFECT OF DIFFERENT PHOTO LINEUP DESCRIPTIONS OF AN EYEWITNESS TESTIMONY ON IDENTIFYING SUSPECTS IN A CRIMINAL INVESTIGATION

Lydia Comer

Heathwood Hall

The purpose of this experiment is to test whether computer generated descriptions or eyewitness testimony descriptions are more accurate in a photo lineup when attempting to choose the correct suspect. This will be tested by showing the subjects three different real life cases and mock photo lineups, each consisting of 6 photos, four of which are filler photos and the remaining two are photos of the innocently convicted suspect and the guilty suspect. All subjects saw the same three photo lineups and background information of the real life criminal case and trial, however one group was presented with the eyewitness testimony describing the suspect and the other group was presented with a computer generated description. The subjects then chose who they best thought matched the description that corresponded with their group for each lineup. The hypothesis is that if subjects are given the computer generated description, then they will be more likely to choose the correct suspect in the photo lineup. The null hypothesis is if subjects are given the description from the eyewitness testimony, then they will be more likely to choose the correct suspect in the photo lineup. The two control groups proved that there in fact was not a significant difference between the two descriptions, thus rejecting the hypothesis that the computer generated description was more accurate. The null hypothesis was also rejected, that the eyewitness testimony would be more accurate, because the data showed no significant difference.

#### THE APPLICATION OF THE PRISONER'S DILEMMA ON THE ABILITY OF DIFFERENT AGE GROUPS ON THE ABILITY TO TRUST OTHERS ONLINE

Gabriel Corn

Spring Valley High School

With the rise of the internet more people are beginning to rely on it. People may be more likely now to trust someone on the internet even if they had previous bad experiences. It was hypothesized that elementary students would be more likely to sell out in comparison to adults and high school students. This research was to find if a person will continue to choose the same answer even if they are betrayed in another experience. Groups of varying ages were assembled and told upon completion of the project they would get a reward based on how many points they earned. They were then told the rules to the prisoner's dilemma, provided forms to fill out, indicating whether they would sell out their partner or keep quiet, and after this they were told what their partner answered. This was repeated with randomized partners nine more times, but on the last trial they were asked to explain how they felt about the partners they were given throughout. An one-way anova test showed that there was a significant difference between groups [ $F(2,37) = 4.94, P = >.05$ ]. Post hoc comparisons using a Tukey test indicated that the mean score for Adults ( $M = 2.75, SD = 1.9129$ ) was significantly different from high school students ( $M = 6.64, SD = 3.01$ ). This showed that High school students were more likely to sell out in comparison to adults.

#### FLUSHED AND FROZEN: DEVELOPING OPTIMIZED METHODS FOR WHOLE BODY PERFUSION OF A MOUSE PRIOR TO CRYOPRESERVATION

Gayle Cunningham

Governor's School for Science & Mathematics

Mentor: Demetri Spyropolous, Medical University of South Carolina

Every day, people are dying due to their inability to obtain organ transplants, as an organ will only remain viable for ten hours after it is harvested. A better method of organ preservation that does not compromise the tissue of the organ is required in order to extend the time from organ collection to transplant. The goal of this project is to develop a method for a whole body

mouse perfusion that results in the most viable tissue after freezing and thawing back out. Tissue crystallization during in the freezing process varies in severity depending on how well the perfusate was distributed in the body, which results in nonviable tissue. We injected seven and a half blood volumes were injected into each mouse. Through four trials, a variety of perfusion methods were implemented, including use of different perfusion sites via the left and right ventricle, and different perfusates, such as PBS (phosphate buffered saline) and the cryoprotectant "Special K Special Sauce." Blood samples were collected throughout the perfusion to measure the hematocrit levels as the perfusion progressed. The perfusion into the left ventricle using PBS was predicted to produce the most stable decline in hematocrit; however, the samples with "Special K Special Sauce" would be more viable after thawing, due to an antifreeze component that will prevent the tissue from crystalizing when cooled. The use of these hematocrit values as well as the future viability tests will provide insight into the best hope to develop an almost universal preservation method.

USING RACE PROTOCOL TO GET FULL LENGTH GENE FRAGMENTS OF CANDIDATE GENES SELECTED IN  
*PASPALUM VAGINATUM* AND *ARABIDOPSIS THALIANA*

Samantha Czwalina  
Governor's School for Science & Mathematics  
Mentor: Hong Luo, Clemson University

The environmental impact of watering gardens and lawns is becoming an increasing problem for the agricultural industry. Water waste has forced strict regulations on the usage of water, and using recycled water for lawn care can be ineffective due to the harsh salts and contaminants present. The sea grass, seashore paspalum (*Paspalum vaginatum*), has exhibited tolerance to high salinity conditions and is currently being investigated for this tolerance. The research conducted focused on identifying and amplifying six candidate genes that may play a role in *P. vaginatum's* ability to tolerate high salt contents. Gene fragments for *P. vaginatum* and the control plant *Arabidopsis thaliana* underwent a RACE (rapid amplification of cDNA ends) protocol in order to obtain the entire gene sequence. Eleven out of twenty-four gene fragments successfully amplified through RACE and PCR reactions. After successful amplifying and creating gene sequences for all candidate genes, they will be transformed into *E. coli* for testing. This testing will reveal how the genes respond to high levels of salt stress. This knowledge will contribute to the understanding of how gene expression affects the plants' response to high levels of sodium. If these genes are confirmed to help aid with salinity resistance, they have the potential to be inserted into grass species that would help benefit plant survival.

USING NON-TRADITIONAL RESOURCES TO BUILD TEMPORARY HOUSING FOR THE HOMELESS

Dennis Daly  
Governor's School for Science & Mathematics  
Mentor: Michael Nixon, Meadors, Inc.

The main goal of this research project was to design a housing structure to address the homelessness problem in Charleston, South Carolina. Homelessness is an unsolvable problem – as long as there is a structured society, there will be people who will be homeless. That being said, it doesn't prevent ways of reducing homelessness. It is recognized that there are certain individuals that don't want to live in a home, and would rather be living outside (i.e. with no designated home). Therefore, this project isn't meant to integrate those individuals into housing, but rather the goal was to design a temporary home for those types of citizens. This temporary housing environment would be used as a proper shelter from the outdoors for the homeless citizens. It is a way to provide shelter while these citizens work on a way to get back on their feet. The housing is designed to be modular, in that, multiple units can come together to build a larger structure. Much of the work done on this project at Meadors Inc. was on the mathematical, and conceptual aspects of the project. Consequently, any physical testing on the structure was minimal. Various calculations were done on the structure regarding the several forces that may act on the structure. Although it was not tested, a junction point was designed and built.

THE EFFECTS OF TENSION, CURVATURE, & LIPID DIFFUSION ON THE ENRICHMENT OF RAS PROTEINS IN THE  
CELL MEMBRANE

Nina Daneshvar  
Dutch Fork High School  
Mentor: Mark Uline, University of South Carolina Columbia

An intriguing part of the cell membrane that provokes study is protein anchor enrichment on the cell membrane. Specifically, recent *in vitro* studies involving the enrichment of Ras proteins were done to see how enrichment was affected by changes in membrane curvature and evinced that Ras proteins inclination to highly curved membranes. Other research done *in vivo*, however, provoked further research of this mechanism since when highly curved protrusions were created in living cells, Ras proteins continued to show affinity for the inner leaflet despite what would be assumed as increase in lateral pressure. This would provoke research to determine the exact mechanism (tension, curvature, lipid diffusion tendencies) affecting Ras protein spatial localization. Since mutated Ras can initiate uncontrolled cell division (cancer), this research would allow for deeper understanding of the mechanisms of the Ras protein in order to inhibit uncontrolled signaling and binding to the cell membrane. The computer program will be used Fortran to create multiple model membranes and measure the ratio of relative densities of anchors associated with the N-Ras protein as a function of tension and concentration of lipids in the outer leaflet. The hypothesized belief would be that Ras proteins bind to the inner leaflet more with increased tension and concentration of

lipids in the outer leaflet in vivo; results instead proved that it is more so the concentration of lipids in the outer leaflet that drive a shift in the lateral pressure fields to allow more Ras protein enrichment in the inner leaflet in vivo.

#### A NOVEL TECHNIQUE TO PURIFY WATER USING THE COAGULANT PROPERTIES OF MORINGA OLEIFERA TO FILTER PHARMACEUTICALS, HEAVY METALS, AND HERBICIDES FROM CONTAMINATED WATER SOURCES.

Sarayu Das  
Spring Valley High School

In recent years increasing levels of pharmaceuticals, heavy metals, and herbicides have been detected in the rivers of North America. Purpose of this experiment was to create cost-effective, eco-friendly water purification system that can filter out seven classes of pharmaceuticals frequently found in the waters of United States (Tri-sprintec, Ibuprofen, Prozac, Diflucan, Lipitor, Amoxicillin, and Metformin), along with two heavy metals (Lead and Chromium), and a herbicide (Atrazine). Moringa oleifera is a plant grown in areas of South America and Asia and is known for its seeds' coagulant properties to reduce water turbidity. However, there were no studies conducted on removing pharmaceuticals using Moringa oleifera, and hence used in this experiment. It was hypothesized that if contaminated water with pharmaceuticals, heavy metals, and herbicide are run through the filter, then concentration of these contaminants in each of the water samples would decrease, because coagulant properties of Moringa oleifera should filter these harmful contaminants from water. This was achieved by building a multiphase filtration system with fine sand, coarse sand, and sawdust as pre-filter and Moringa seeds as water coagulant. This filtration system tested efficiency and percentage removal of these contaminants in three phases. The contaminant water samples were run through filter and concentration of these chemicals were measured before and after the experiment. T-tests were run to compare controls and trials for each contaminant. The p-values of six pharmaceuticals and both heavy metals were less than alpha value of 0.05, and thus the alternative hypothesis could be supported. However, Prozac and Atrazine showed inconsistent results warranting further tests. This experiment thus confirms the coagulant properties of Moringa oleifera and its effective absorption rate of 80% on pharmaceuticals and heavy metals.

#### THE CREATION OF AN APPLICATION ON THE UNDERSTANDING OF SENSORY OVERLOAD OCCURRENCES

Parker Davis  
Chapin High School

The project focuses on the creation of iOS-based software to link devices to track stimuli in the brain and vital signs on the persons of elementary-middle school aged kids. The application gives way to studying the signs of outbursts in the minds of many with mental handicaps and the brain and body's response to outside and naturally caused influences. The project is to be carried out on the campuses of Lake Murray Elementary and Chapin Intermediate School. Three individuals are 'wired' with the proper devices that passively record data and be activated by certain thresholds to obtain more detailed and specific data points. The current hypothesis about the direction of the data is that with the tools given to supervisory adults, children struggling with environmental-based sensory issues will be properly treated. By tracking these vital aspects of the body and mind, children and adults' conversations about outbursts or breakdowns will be much more focused and effective.

#### INHIBITION OF TBK1 AND IKKε BY AMLEXANOX SYNERGIZES WITH BORTEZOMIB TO REDUCE MYELOMA CELL GROWTH

Sarah Davis  
Home School

Mentors: Deborah Galson and Quanhong Sun  
University of Pittsburgh School of Medicine, University Of Pittsburgh Cancer Institute

Multiple myeloma causes increased osteoclast activity and decreased osteoblast formation that results in extensive bone damage. The aim of this study was to explore the potential usefulness of Amlexanox, a TBK1 and IKKε kinase inhibitor that decreases osteoclastogenesis, as a potential therapeutic for MM bone disease. Amlexanox alone slowed the growth of myeloma cell lines. Therefore, this study tested the effects of combining Amlexanox with a current myeloma therapeutic, the protease inhibitor Bortezomib, on myeloma cell growth and apoptosis. First, the effects of a single suboptimal dose of Amlexanox and Bortezomib alone and in combination on five MM cell lines were assessed using CellTiter-Glo assays. This was followed by analyses of a set of total drug concentrations (¼, ½, 1, 2, 4-fold) that maintained a constant ratio of Amlexanox to Bortezomib based on their IC50s to determine whether their combined effect on the myeloma cells was antagonistic, additive, or synergistic. The results of the assay showed that the drugs combined antagonistically at low doses and synergistically from the IC50 up. In addition, the effects of Amlexanox on different stages of bone marrow differentiation to osteoclasts were tested using a TRAP assay. These results showed that the first 48 hours after exposure were the most critical to decrease osteoclast formation. The results of this study suggest that Amlexanox combined with Bortezomib is a potential therapeutic treatment for myeloma patients and the Amlexanox may help to prevent excess osteoclastogenesis in myeloma patients.

OPTIMAL WEIGHT LOSS METHODS FOR PHYSICAL PERFORMANCE IN SOUTH CAROLINA ADOLESCENT  
WRESTLERS  
Garrett Dean  
Chapin High School

In its current form, this project's purpose is to find a correlation between specific weight loss methods in wrestlers, and those wrestlers' performance and energy levels on the mat. This topic is being investigated in order to help make the practice of weight cutting safer, and prevent injuries in high school wrestlers that are a result of excessive weight loss using dangerous and ineffective methods. In order to gather data for the project, wrestlers were polled after their matches for their before-season weight, their beginning-of-week weight, their weight-in weight, their weight cutting methods used, and their energy levels during their matches. Data was also gathered by watching each wrestler and rating them on a performance scale (GPT). Once sufficient data is gathered, a mixed model will be used in order to find correlation between techniques and physical performance. The results and data from this project are helpful in the real world because that they show optimal weight loss techniques for the health, energy levels, and performance of wrestlers. Then these techniques can be implemented in wrestling rooms, and less effective methods can be omitted, allowing the practice of cutting weight to become safer, and more practical for high school wrestlers.

GROWTH OF *MANDUCA SEXTA* FROM EGG TO PUPATION  
Elizabeth DeLanghe  
Governor's School for Science & Mathematics  
Mentor: Charles Beard, Clemson University

The Tobacco Hornworm, *Manduca sexta*, is a type of sphinx moth reared for the purpose of studying its proboscis. It is indigenous to North America. Its larval diet consists of the leaves of the nightshade family, while its adult diet revolves around the nectar of white flowers. There have been issues at Clemson's entomology labs concerning the feeding of the adults and overall survival rate during studies of the species. This is due to a diet lacking in nutrients in the final larval stage before pupation. In the first part of this study, the caterpillars were placed in modified mosquito breeders with different types of food, all containing some form of carotenoids (except for the control). They were fed and grown, with several of the food types causing the mortality of their ten designated caterpillars and only two being able to take about half of the original population to pupation. This was crucial into the second part of this experiment, as it required the caterpillars to survive to a certain size and age and be healthy enough to develop into pupae. After a few weeks, older and larger caterpillars were introduced to carotenoids later in their life cycle. These had been previously eating the commercially made food meant specifically for them. The ratio of the commercially made food in their diets to the carotenoid food was changed to see if they would have better vision after they made it to adulthood. The caterpillars grew and the survivors pupated.

DESIGNING AN ATTACHABLE ACCESSORY TABLE FOR WHEELCHAIRS  
Hayden Derrick and Sam Coleman  
Center for Advanced Technical Studies

As more Americans become wheelchair dependent, they are hesitant to lean forward to perform daily activities such as reading or eating. If we were to create a table that can be attached to the wheelchair, then people who are wheelchair bound will be able to perform activities such as reading and eating without having to lean forward because the table will always be there for them. In order to do this we will design multiple prototypes each being more advanced and innovative than the last. We will achieve this by designing one prototype at a time and receiving feedback from users to direct us toward our final product design. Each design will take steps, in operation and materials, towards our final goal product. Results will be collected via a survey which will be given to anybody who test the table. This chart has the categories of: usefulness based on size, if the table can be stored beside the wheelchair, how easily the table can be adjusted to meet the requirements of the patient, and if the table is sturdy enough to perform daily task on. We will analyze our data based on the feedback from the survey and on criteria which includes: sturdiness, usability, easily stored, and adjustable. Throughout the course of our research we will create more advanced prototypes in order to reach our final product goal. We will adjust designs and operations of our table as our research is conducted. Our finding will tell us if creating a table that can be stored beside a wheelchair and then turned up with a motor is actually possible and if there needs to be any modifications to our project. In the future, we hope that this table will lead to us getting a patent on the table which will hopefully allow us to produce this table for the growing number of people who are becoming wheelchair bound.

THE EFFECT OF TEMPERATURE ON ZINC LEACHING FROM RUBBER TIRE MULCH  
Elizabeth Dillon  
Spring Valley High School

Scrap tires are being recycled into many products in order to bypass slow degradation in landfills. Recycled rubber tire mulch contains zinc oxide used in tire formation that can be released through the creation of leachates. This study examines the relationship between temperature environment and leachate zinc concentration. After observing rubber mulch surface temperatures in conjunction with other factors, it was hypothesized that higher temperatures would lead to increased zinc release by rubber mulch and higher leachate zinc concentrations. Leachates were created by mixing 10 grams of mulch and 200 mL distilled water and placing in 50C, 29oC, and 71oC environments for 24 hours. Zinc content in ppm was then tested

and statistically analyzed with ANOVA at  $\alpha=0.05$ . A significant decrease in mean leachate zinc concentration as temperature increased was shown between the 29°C ( $M = 5.733$ ,  $SD = 1.486$ ) and 71°C ( $M = 4.133$ ,  $SD = 0.516$ ) treatments and the 5°C ( $M = 6.533$ ,  $SD = 0.743$ ) and 71°C treatments ( $F(2, 42) = 22.19$ ,  $p < 0.01$ ). Therefore, within these intervals, decreasing temperatures increased rubber mulch breakdown and leachate zinc concentration. Because tires are created at high temperatures during the vulcanization process, it is reasonable to consider that tires are strongest at higher temperatures. Studying the effect of rubber mulch leachates on soil and various organisms would provide a direct study to more accurately deduce potential environmental impacts.

#### EFFECTS OF CARBON NANOTUBES ON THE BALLISTIC APPLICATION OF SPIDER SILK

Parker Dixon  
Chapin High School

A large problem in our modern time is the lack of advancement in body armor for personal protection. Since the 1970's all soft armor has used kevlar or a substance that is chemically similar. Kevlar vest that are used by police, FBI, and the Secret Service are inflexible, heavy, and do little to reduce the impact of a bullet. This project answers the question of whether or not it is possible for Carbon Nanotube infused Spider Silk to stop a .44 magnum round with lighter weight, more flexibility, and better energy dispersion than currently out on the market. Through extensive research and the aid of experts in the field of materials engineering, spiders, and a few researchers, I was able to solve it out on paper whether or not the material could stop the round. While I can not test the actual fiber, due to natural silk being so hard to produce and synthetic silk not yet produced, mathematically the fiber excels on paper being much stronger, at 5.4 GPa vs kevlar's 3 GPa, and more flexible, at 30% compared to 10%, than competitors. This project provides information on, and concludes, that mechanically it is possible to use Carbon Nanotube Infused Silk to stop a .44 Magnum round. This will pave the way for current body armor to improve and change.

#### A STUDY ON THE SEVERITY OF NARCOTIC DIVERSION IN HOSPITALS

Alexander Dixon  
Chapin High School

This project is about the narcotic diversion, with specific respects to fentanyl, that is occurring in hospitals. Narcotic diversion is the stealing or syphoning of drugs from reserves. Fentanyl is a highly sought after and addictive, and sold for absorbent amounts on the black market. The main problem with fentanyl diversion is caused by doctors, since anesthesiologists for example work with narcotics multiple times a day, with almost unlimited access. A survey of 260 anesthesiologists from the Medical College of Wisconsin graduating between 1958 and 1988 reported that 32 percent used drugs to "get high" and 15.8 percent had been drug dependent. (Medical college of Wisconsin) The optimal time for this diversion to occur is at time of disposal. This is when the doctor wastes the leftover drug he/she didn't use on the patient. This is the optimal time for the diversion of fentanyl, since at this time the only precautionary measure is notarized disposal. Notarized disposal is a procedure in which a nurse watches a doctor waste the narcotic, and in the case of fentanyl a clear liquid, and co-signs saying that the doctor did actually dispose of the narcotic. The problem with this system is that in some cases, like fentanyl, the liquid is clear. My project looks at the scope of this problem and the validity or necessity of a solution or form of preliminary test for fentanyl.

#### THE DEVELOPMENT OF LIQUID ELECTRODE BATTERIES WITH AQUEOUS LITHIUM CARBONATE

Paul Dubberly  
Spring Valley High School

Flexible, yet powerful batteries are needed to power numerous devices, and a simple battery with liquid electrodes would be highly flexible. Because of the chemical advantages of lithium-ion batteries, materials common in lithium batteries but as solutions could be used to create a highly productive and flexible battery. The purpose of this experiment was to create and test a simple battery using liquid electrodes, but with the relative strength of a lithium-ion batteries. It was hypothesized that if aqueous lithium carbonate were used as the cathode material in a simple battery, the battery would produce more power than if hydroquinone were used as the cathode. A suspension of graphite and water in a mass ratio 1:2.4 was placed in a 50 mL beaker. Also, 0.1 molar  $\text{Li}_2\text{CO}_3$  (aq) was placed in another 50 mL beaker. A wire was placed with one end in each beaker to allow electrons to flow. The same was done again with Hydroquinone instead of  $\text{Li}_2\text{CO}_3$ . The power produced in volts by Lithium Carbonate ( $M=0.23$ ,  $SD=0.17$ ) was significant,  $t(9)=3.72$ ,  $p=0.002$  when compared to 0. The power produced in volts by Lithium Carbonate ( $M=0.23$ ,  $SD=0.33$ ) and by Hydroquinone ( $M=0.23$ ,  $SD=0.17$ ) do not differ significantly,  $t(13)=1.32$ ,  $p=0.10$ . Therefore, aqueous lithium carbonate can be used as a liquid battery material though will need more testing to show greater production than other liquid batteries.

## COMPARING INTERACTION ENERGIES OF WATER AND NH<sub>2</sub> ADSORBATE ACROSS VARYING COVERAGES

Natalie Duprez

Governor's School for Science & Mathematics

Mentor: Rachel Getman, Clemson University

Catalysts are used in many industrial processes to make essential chemical reactions feasible. Therefore, it is important to understand the details of how catalysts promote reactions, particularly in the aqueous phase, where water is involved. In this investigation, the coverage of the adsorbate was changed, where the adsorbate was the group of molecules interacting with the catalyst, in order to determine how the energy of interaction between the water and adsorbate changes. Five unit cells were constructed, which included an 18x18x3 Pt catalyst surface, an adsorbate layer directly above the catalyst, and a randomly generated H<sub>2</sub>O layer. The five coverages of adsorbate used were 1/324 ML, 1/36 ML, 1/4 ML, 1/2 ML, and 1 ML. Two molecular dynamics simulations were run using the LAMMPS (Large-scale Atomic/Molecular Massively Parallel Simulator) Molecular Dynamics Simulator. First, frames were generated to simulate the movement of water. Then, the interaction energy between the adsorbate and water for each frame was calculated. This energy was then averaged to find the interaction energy for each unit cell, and the interaction energy per NH<sub>2</sub> molecule was also calculated. As expected the energy became more negative with an increase in the number of NH<sub>2</sub> molecules. For the energy per NH<sub>2</sub> molecule, there was a minimum at the 1/4 ML cell. However, more coverages should also be explored to better support these results and ensure that there is a real correlation.

## BANDAGE TO DECREASE COAGULATION TIME

Katie Dzoba

Center for Advanced Technical Studies

The objective of this study is to determine which substance, when added to blood, causes the fastest coagulation time (Phase I), and to develop a bandage that this substance will be integrated into (Phase II). It is hypothesized that if a substance decreases coagulation time and is infused into an innovative bandage design, then it will successfully stop bleeding from a minor wound faster than bandages that are already on the market. Coagulation time will be collected among volunteers' blood samples via pricking their finger, and all-natural tea and coffee will be added to their blood samples to be analyzed under a microscope to time the exact clotting time. These coagulants both contain Tannic acid which has astringent qualities to stop bleeding. Sheep blood clots most similarly to human blood and will be placed onto the final design of the bandage to further determine if the bandage fulfills the hypothesis. The sheep blood clotting time will be compared using other bandages that exist in the market to determine if this innovative design is more effective at stopping bleeding than preexisting bandages. There is currently no data on blood clotting time using the two coagulants and further testing and trials need to be run before moving onto Phase II.

## ASSOCIATION BETWEEN DIETARY INTAKE OF ADVANCED GLYCATION END PRODUCTS AND PROSTATE CANCER AGGRESSIVENESS

Wenxin Fan

Spring Valley High School

Mentor: Susan Steck, University of South Carolina School of Public Health

Cancer is a genetic disease that results from mutations in cell function, growth, and division. Epidemiological studies analyze the health and disease cause and effects of conditions in certain populations and are the basis for many etiological studies. Research has shown that diets of high caloric intake consisting of red meat and fatty foods promote the growth of carcinogens. This occurs due to increase insulin resistance, chronic inflammation and hyperglycemia. Advanced glycation end products AGEs are formed from the glycooxidation of macromolecules such as proteins, lipids, and nucleic acids. AGEs act in reducing tissue flexibility when forming crosslinks with extracellular matrix proteins by binding with transmembrane, pattern recognizing receptors (RAGEs). Endogenously, AGEs are accumulated when the body undergoes metabolic oxidative stress. Aging also allows for the accumulation of AGEs in tissues. Exogenously, AGEs accumulate and are formed when food is cooked with dry heat and high temperatures. The intake of food and beverages as well as the practice of smoking introduces more AGEs to the body. In 2001 it was reported that incidence rates of prostate cancer were 50% higher and mortality rates were 150% higher for African American than Caucasian Americans. Possible factors that contributed to this may be racial differences in prostate cancer screening and care or seeking behaviors, which results in delayed diagnosis and less aggressive or appropriate treatment. Racial differences in etiology and pathology of patients may also influence the aggressiveness and progression of tumor cells.

## THE EFFECT OF SLEEP ON AVERAGE WEIGHTED GPA

Justin Feagin

Chapin High School

While at high school, many students get a varying amount of sleep depending on their life and schedules. Also, these students all have weighted GPA's. This project looks to see if there is a pattern between how much sleep students get on average compared to their weighted GPA. This data can be obtained through a anonymous survey asking students to simply

state how much sleep on average they get each night, what time they usually go to bed and wake up, and what their weighted GPA is.</p>

#### HOW FURTHER INTERNET USE ACCELERATES FUTURE INTERNET USE

Ben Feldman  
Heathwood Hall

The purpose of this experimentation is to assess the impact of how internet use to retrieve information influences how we access future information. Use of search engines such as Google to answer difficult questions results in an artificial dependence on internet usage to answer trivia questions which the subject should be able to answer. With easy accessibility to the internet subjects were potentially more likely to become cognitively dependent which may interfere with their future ability to independently process information. This dependence could decrease cognitive performance and productivity when the internet is not available. The current experiment is an extension of a previous study by Benjamin Storm et.al. This study was designed to see if the same results were true in a high school population. The initial hypothesis was that if high school students were given the choice of using the internet or their own memory to answer a set of questions, then the students would depend upon the internet instead of their memories to answer the trivia questions. However, the opposite appeared to be true because the null hypothesis was supported by the results of this study.

#### THE CORRELATION OF PATIENT SELF ASSESMENT OF SCAR TISSUE TO PHYSICAL THERAPIST EVALUATION

Olivia Fladung  
Chapin High School

The body's tissue cells that regenerate post injury form adhesions. These adhesions act as strong bonds that pull and shrink causing restricted motion within an affected area. For this study consented patients filled out a Patient Observation and Self Assessment Scale. This scale is also filled out by the patient's physical therapist. The scores are measured, averaged and correlated with a Matched Pairs T Test. This study is to develop the understanding of patient self perception of their scars in comparison to the physical therapist's evaluation. The patient gender, age range, surgery date, incision closure, and a picture is observed from the patient with consent. The vascularization, pigmentation, thickness, relief, pliability and evaluation score is taken from the therapist's observation. The pain, itching, coloration, stiffness, thickness and irregularity is asked of the patient self observed of their scar and an average score is taken. I hypothesize that females and patients who do not manage their scars will have higher personal scar assessment scores in comparison to the therapist score. The same scar management routine is given to each patient recorded in data collection.

#### THE EFFECT OF MARCHING BAND AND NON-MARCHING BAND ACTIVITIES ON A STUDENT'S ACADEMIC ACHIEVEMENT

Tyrell Fleshman  
Spring Valley High School

It was hypothesized that there is a positive association between dietary AGE intake and prostate cancer aggressiveness due to increased oxidative stress and inflammatory response that results from the advanced glycation end products. Researchers from the University of North Carolina at Chapel Hill and Louisiana State University conducted a comprehensive, multidisciplinary study for causes of racial disparities in the aggressiveness of prostate cancer, and the nutrition and dietary survey from the study

#### THE ROLE OF UPARAP, A CELL SURFACE COLLAGEN RECEPTOR, IN MOUSE MODEL OF EMPHYSEMA

Karli Fletcher  
Governor's School for Science & Mathematics  
Mentor: Lynn Schnapp, Medical University of South Carolina

The purpose of this research was to determine whether or not the collagen uptake receptor, uPARAP, plays a role in the matrix remodeling of the lungs during the development of emphysema. This research was completed using knock out (KO) uPARAP mice that had been smoked with tobacco or not smoked, and smoking and non-smoking wild type (WT) mice. Many methods were used during this research to draw conclusions, including genotyping, protein assays, white blood cell differential, and quantitative real-time polymerase chain reaction. From genotyping, it was confirmed that all of the study mice involved in the experiment were organized correctly. The protein assays showed that there appears to be no significant difference between the protein concentrations of the non-smoking and smoking WT and KO uPARAP mice. The white blood cell differential showed that there appears to be a greater amount of neutrophils in the lung tissue of the KO uPARAP mice than the WT mice, both before and after smoking. The results of quantitative real-time polymerase chain reaction seemed to confirm that pattern by displaying that there may be greater expression of a neutrophil chemoattractant in the mice that had the largest number of neutrophils. Quantitative real-time polymerase chain reaction also showed that uPARAP does not appear to be regulated by smoke, and collagen expression in the lungs may decrease with smoking.

## THE EFFECT OF LED LIGHTING ON THE DETERIORATION OF OIL PAINT

Jasmine Marie Flora  
Spring Valley High School

combined with a database for advanced glycation end product content in commonly consumed foods was used to create a new database to quantify the survey results with the AGE content. A SAS code was then generated to process the 2000 survey results to quantify average AGE content per day per person. Data collected about the severity of the cancer and about the race of the participants will then be combined with the data for AGE content to search for any patterns or relationships.

## VARIABLE TOLLING FOR EXTERNALITY REDUCTION IN COLUMBIA, SOUTH CAROLINA TRAFFIC

Samuel Floyd  
Governor's School for Science & Mathematics  
Mentor: Chandini Sankaran, University of South Carolina Columbia

Rush hour traffic produces a number of negative externalities areas such as pollution, congestion, and oil dependency. This study aims to quantify these effects in Columbia, South Carolina in an attempt to ascertain the extent of their monetary impacts and make loose expectations for what can be done to alleviate the issue. Traffic counts were obtained at one intersection in downtown Columbia and the data was analyzed with an index that quantified the effect of externalities. In addition, emission data was compared with that provided by the EPA for Richmond County to see the contribution of yearly emissions from a single intersection. The results show a presence of externalities, the extent of their importance a question yet to be determined as well as what the most suitable solution is given a more comprehensive analysis of traffic flow.

## FINDING THE SPLITTING NUMBERS OF TILES

Jacob Folks  
Governor's School for Science & Mathematics  
Mentor: Gregory Clark, University of South Carolina Columbia

In this research, the bounds of splitting numbers for finite tiles and their characteristics were analyzed. From prior research by Dr. Cooper, it was proved that the lower bound of splitting numbers is 2, and an upper bound is  $|T|+1$ , where  $|T|$  is the number of elements in a tile. The main result of this research was proving a tighter upper bound that is  $|T|$  for all finite tiles  $T$  by the use of an algorithm that can split any  $|T|$ -covering without fail. This research also proved that translations, reflections, and scalar multiples of tiles have equal splitting numbers. This allows the tiles to be grouped into categories based on their root tile.

## THE EFFECT OF AEROBIC EXERCISE ON THE ELECTRICAL OUTPUT OF A THERMOELECTRIC ARMBAND

Cody Foster  
Spring Valley High School

Today's society is governed by battery life in electronic devices. Research was conducted to experiment with the use of the human body's ambient energy as a possible alternative source in the form of thermoelectricity. The purpose of this experiment was to determine which aerobic exercise would produce the most electric energy in millivolts (mV). It was hypothesized that jogging would produce the most electric energy due to the enhanced blood flow and overall increase of activity. The participant wore a thermoelectric armband and partook in three differing activities, each for ten minutes: sitting (the control), walking, and jogging. Sitting had an average of 6.453mV, walking had an average of 7.847, and jogging had an average of 11.060. The variation between the trials was found significant, as indicated by an ANOVA  $F(2, 42)=50.39$ ,  $p<0.05$ . A tukey test indicated that the significant difference was between all of the trials; sitting, walking, and jogging.

## "ACADEMICALLY GIFTED": HOW DEFINING STUDENTS AFFECTS SELF-ESTEEM

Emily Franklin  
Chapin High School

Academically gifted programs are prominent in American education. Students are defined as academically gifted at a young age, most often around second or third grade using written tests or standardized test scores. Students who are involved in gifted programs are often given more opportunities and pushed to do more than those students who are not defined as gifted. A survey was created to analyze a student's self-esteem. The survey asked the students questions about their self concept, home life, school habits, and interactions with others. Each question is a statement and must be answered with "always," "most of the time," "sometimes," or "never." They're given a score (always is 4, most of the time is 3, etc.), and the higher the total score, the higher their self-esteem. Surveys were administered to students in randomly-selected homeroom classes by their homeroom teachers. A two sample t-test was conducted and the p-value at a 90% confidence level was .0767. Because the p-value at this confidence level is .0767, the data is significant enough to reject the null hypothesis that there is no significant between the self-esteem levels of gifted students and those of nongifted students, and support the alternative hypothesis that the self-esteem levels of gifted students are higher than those of nongifted students.

## TESTING THE ABILITY OF A PROSTHETIC TO RESIST CHANGE IN POSITION AND HANDLE WEIGHT

Royce Frye  
Spring Valley High School

Currently there are over 41,000 people in the United States who have lost an upper limb (Williams and Walter 2015). In order to help these individuals live the most normal life possible, prosthetics are made. Unfortunately, they are very expensive. Two prosthetic structures were tested during this study, one was made with moldable plastic and strap on attachment mechanism, and another was made with aluminum and clip on attachment mechanism. These were placed on a vertical approximation of an arm upside down, and weights were placed on the hook, causing the prosthetic to (possibly) slip off. The structures were attached to the arm at a certain point, and at the end of the test, the distance away from the first point was measured. After this, weights were attached to the prosthetic to see when the prosthetic starts to fail, or break. It was found after the tests and an ANOVA that neither the clip on, nor the strap on performed better ( $p(0.628) > \alpha(0.05)$ ), meaning that the only determining factors in choosing the prosthetic are weight and comfort. The aluminum being lighter, it seems to be the better design.

## THE EFFECTS OF ESTROGEN AND PHYTOESTROGEN ON MCF-7 HUMAN BREAST CANCER CELLS

Emily Giep and Aliyah Jamison  
Dorman High School  
Mentor: Neval Erturk, Converse College

With controversy surrounding hormone replacement therapy in postmenopausal women, phytoestrogen has been used as an alternative to alleviate menopausal symptoms. Due to its estrogenic properties, phytoestrogen's usage has raised breast cancer concerns. The purpose of this experiment was to observe how the growth of MCF-7 (Michigan Cancer Foundation-7) breast cancer cells were affected by different concentrations of estrogen, phytoestrogen, and the combinations of both. It was hypothesized that phytoestrogen would enhance estrogen's stimulatory effect on cell growth of MCF-7 cells. The MCF-7 cell samples, along with their designated concentrations of estrogen and phytoestrogen, were placed in the incubator for twenty-four hours, forty-eight hours, and seventy-two hours. MTT (3-(4,5-Dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide) salt and dimethyl sulfoxide (DMSO) were added at different time intervals. The colorimetric readings were then taken using the Epoch BioTek Microplate reader. The results showed that, at lower concentrations, phytoestrogen increased cell proliferation. The effect of phytoestrogen on cell viability seemed to be opposite of the effect of estrogen alone. The effect at seventy-two hours followed the normal trend of estrogen only at the E1 and phytoestrogen combination. The rest of the combination doses for other estrogen concentrations were opposite of estrogen alone. The overall effect of phytoestrogen and estrogen combinations are still unknown. The unknown effect on circulating estrogen level on gene expression as well as the agonistic and antagonistic nature of phytoestrogen on the different estrogen receptors might be the explanation for not supporting the hypothesis that phytoestrogen enhances cell viability of MCF-7 cells.

## EFFECTS OF *GANODERMA LUCIDUM* ON CELL MIGRATION

Alexander Giep  
Dorman High School  
Mentor: Neval Erturk, Converse College

*Ganoderma lucidum* (reishi) is a fungal supplement known for its therapeutic properties. In this project, we investigated the effects of water extracts of reishi on cell migration of MCF-7 breast epithelial cell line. MCF-7 cells were cultured to 90% confluence in 12 well plates. Two scratch wounds per well were created by using a needle at the appropriate time point. Uniform wound formation was confirmed under the microscope. At the appropriate time point cells were fixed and stained. Wound images were taken under a 10X objective and the wound closure quantified using ImageJ software. We observed that at 12 and 18 hour treatment period reishi prevented wound closure significantly ( $p < .05$ ). We recommend further evaluation of the effects of reishi on cell migration and to further explore the molecular mechanisms involved.

## THE EFFECT OF VARIOUS GOLF BALL TYPE ON DISTANCE TRAVELED

Spears Goodlett and Jackson Pringle  
Heathwood Hall

In this experiment, the effect of the price and brand of golf balls were tested and it was determined whether specific brands would be needed to increase one's success rate or total meters in one round of golf. A total of three people were included in the testing of this project, a bad player, a good player and an experienced player. Each player hit a total of 20 shots with each ball over the course of 2 testing days. The club used to hit the ball was selected as one of the most neutral clubs in the game of golf, the sand wedge. The club's loft, or angle of the club's face, was 54 degrees. The three subjects were selected specifically from their certain skill level and experience in the game of golf. It was determined if price and various golf ball brands factor into the total distance traveled in one shot. After reviewing the data it was determined that there was a variance but not enough to determine if it was significant to the ball.

## THE CORRELATION BETWEEN THE DISTANCE OF THE OBJECT FROM THE PLATE TO THE RESOLUTION AND DEPTH OF THE HOLOGRAM PRODUCED BY A HELIUM NEON LASER

Nikhil Gottipaty

Spring Valley High School

Mentor: Rao Gottipaty, Adelphi University

The purpose of this experiment was to create higher quality holograms without losing the depth of the image. The hypothesis was that if the distance of the object from the plate was increased then the depth would increase and the resolution would decrease. The setup was created using a Helium Neon laser, magnets, and a shiny red model of New York city. The object was placed 97cm away from the laser and the plate was balanced on the magnets at 95cm. The plate was in complete darkness, and after the plate was placed the table was left alone to stabilize for 5 minutes. After the 5 minutes were up the plate was exposed to the laser beam for 5 seconds. Then the plate was processed using a basic ascorbic acid and bleach process. The data were analyzed using a linear regression t test for the depth of the holograms were  $t(2)=5.05$ ,  $p=0.037$ ,  $r^2=.927$ ,  $r=0.96$  at an alpha value of 0.05. The p value is less than the alpha value of 0.05 so the data for this set is significant. The linear regression t test for the resolution of the holograms were  $t(3)= -9.23$ ,  $p= 0.0027$ ,  $r^2= 0.966$ ,  $r= -0.983$  at an alpha value of 0.05. Again the p value is less than the alpha value of 0.05, so the data for this experiment is also significant.

## IMPROVING THE DESIGN OF PROSTHETIC VEINS

Alexandra Grant

Center for Advanced Technical Studies

Prosthetic veins are used to replaced damaged venous tissue when venous return is not equal to cardiac output. Chronic venous insufficiency (CVI) and varicose veins are two conditions where there is a great disparity between venous return and cardiac output due to damage to the venous tissue as well as the venous valves that prevent retrograde blood flow. Current prosthetic veins do not have valves in them, so the objective of this project was to design a prosthetic vein with valves in case doing so would help prolong graft life and vascular health in patients. In this project, a prosthetic venous valve was 3D printed using a flexible, porous filament. The prosthetic vein was then placed and secured in a prosthetic vein, which was tested using a peristaltic pump and evaluated through input-to-output ratios. The input of the system would be analogous to the cardiac output, and the output of the system would be analogous to venous return.

## CONDUCTIVITY OF SOLID OXIDE FUEL CELL CATHODE MATERIALS

Benjamin Gray

Governor's School for Science & Mathematics

Mentor: Xiao-Dong Zhou, University of South Carolina Columbia

Fuel cells offer a clean and efficient method of generating electricity. However, current technology requires the use of hydrogen, a synthetically produced gas, as fuel. Solid Oxide Fuel Cells can use various fuels, including some hydrocarbons, more efficiently than any combustion cycle. However, current technology requires temperatures of over 800°C for electrochemical processes to advance with reasonable efficiency and speed, necessitating the use of relatively expensive materials in their construction. To reduce operating temperature, cathode performance must be improved, as it is currently a limiting factor. To do this, novel materials and syntheses must be researched. Praseodymium Nickelate ( $\text{Pr}_2\text{NiO}_4$ ), has shown good performance in past investigations, so to verify those results, the electrical properties of the material were to be re-measured using resistance analysis. No reliable results were collected. Further work must be done to verify the experimental method.

## THE EFFECT OF OFF-SEASON TRAINING ON ONE MILE RACE TIMES

Hannah Guess

Chapin High School

Several studies have been done to determine the effects of muscle training on the running economy of different types of runners. Overall, studies suggest that additional muscle training proves to be beneficial for running times. This project answers the question: "Does additional off season muscle training improve speeds in one mile races?". Fourteen runners participated in the study, which took place during the off season for high school track athletes. In a survey, athletes gave their mile race times from the 2016 season as well as the type of off season training they participated in: either muscle training or running training. Athletes then gave their mile race times for 2017 to determine the effect of different training methods. Final times were compared to initial times in a matched pairs t-test with categories based on whether athletes participated in running training or muscle training during the off season. Data showed that the P-Value of the effect of off season muscle training was 0.418, which is statistically insignificant. Although the hypothesis that off season muscle training would be beneficial for high school track athletes was proven incorrect, if a specific training regimen was instituted, the effects could become prove to be more beneficial for the runners.

## THE EFFECT OF THE NUMBER OF TIMES THE BATTERY IS CHARGED ON HOW LONG THE CHARGE LASTS

Allison Hall  
Heathwood Hall

The purpose of this experiment was to find out if the number of times a rechargeable battery is charged decreases the length of time the battery will hold its charge. It was hypothesized that if a rechargeable battery is charged multiple times the length of the time the charge will last will decrease. Eight rechargeable batteries were charged, for one hour and thirty minutes then tested to find the initial voltage. After finding the voltage the batteries were placed into one of four hair trimmers, to run down the charge. A camcorder was used to film the exact time the hair trimmers turned off. A timer was also started as a backup. After the batteries had fully run down, when the trimmers had fully shut off, the voltage was tested again, this was repeated five times with both sets of four batteries. The data showed that the length of charge decreases as the number of recharges increase. Thus the data was conclusive, leading to a conclusion that rechargeable batteries lose charge as they recharge.

## THE EFFECT OF ANTI-PHONE PSAS ON ADOLESCENTS' PHONE USE AND ADDICTION

Wesley Hankinson  
Spring Valley High School

Mobile phones have become a large part in today's society and culture since their creation. They are so ingrained in society that one study found a sample of college students spend an average of 8.79 hours a day on their phone (Roberts, Petnji Yaya, & Manolis, 2014). While mobile phones have evolved to become very useful tools, this amount of usage has raised questions involving the average person's dependence on their device and the problems associated with it. One element of mobile phones in today's society is the ability to watch videos online, specifically on YouTube. Since YouTube is also accessible through most mobile phones, these PSAs could be used to help fight phone addiction, as they are likely to be seen by phone users. Therefore, The purpose behind this experiment was to help find an efficient and effective way of combating phone addiction. The data was collected through the MPPUS survey, and the t-test that was performed produced a p-value of 0.478, suggesting that there was no significant difference. Extra questions were added to the survey to collect further data on the thoughts of the adolescents during this process.

## THE EFFECT OF DIFFERENT CONCENTRATIONS OF POLYETHYLENE MICROBEADS *DAPHNIA MAGNA*

Sydney Hannibal  
Spring Valley High School

Polyethylene is the most commonly use plastic in consumer products and is increasingly being used in the production of consumer products. Because polyethylene is used in products such as face wash and toothpaste, it ends up going down the drain and into the ocean. Due to their small size, nanoparticles could easily be consumed by aquatic animals. This project focuses on the toxicity of polyethylene plastic microbeads on the aquatic environment. The data tests were gathered by exposing the invertebrate *Daphnia magna* to different concentrations of the 50 micrometer polyethylene particles. It was hypothesized that if the amount of the polyethylene microbeads increased, then the *Daphnia magna* will die and the population and amount of *Daphnia magna* would decrease. The *Daphnia magna* were individually placed into containers filled each with 0.24 liters of water and the different concentrations of the polyethylene. 90 total of *Daphnia magna* were tested. 30 *Daphnia magna* were each exposed to 0.0000 grams of the polyethylene microbeads, 30 *Daphnia magna* were each exposed to 0.0005 grams of the polyethylene microbeads, and the last 30 *Daphnia magna* were each exposed to 0.0010 grams of polyethylene microbeads. The experimentation lasted for 11 days. After experimenting, it was concluded that the rates of death among the *Daphnia magna* were not significantly different. The results showed that death of the microorganisms were not widely different between the levels of concentrations, although there were more three more *Daphnia magna* organisms from the group that received none of the polyethylene microbeads that survived at the end of the 11 days, than the other two groups of *Daphnia magna* that did receive the polyethylene.

## IROBOT ROOMBA AND ARDUINO AS AN ACCELERATED LEARNING PLATFORM FOR INTERDISCIPLINARY PRINCIPLES

Chloe Harris  
Governor's School for Science & Mathematics  
Mentor: Yongqiang Wang, Clemson University

Robotics is a field which highlights the importance of interdisciplinary work in STEM. It is important to be able to write efficient and readable code to accomplish a desired task, design hardware components so that they fit together in a way that allows the robot to operate effectively, and to be able to draw on other, more specialized fields of knowledge when necessary. Even at a basic level, some knowledge of software, mechanical, and electrical components is essential. Despite this, most introductory level courses in engineering and computer science fields are taught independently with relatively few courses existing where these skills are taught in conjunction. For students who intend to go into an interdisciplinary field such as robotics, it may prove beneficial to introduce interdisciplinary skills through interdisciplinary means rather than through independent courses. Over the course of my research, a group of students were taught both hardware and software elements simultaneously, with an emphasis on software. By the end of the research period, the students understood enough to create a

basic robotic swarm and to troubleshoot the robots with minimal assistance from their mentors. All participating students entered the lab with minimal prior knowledge in these fields.

#### THE IMPACT OF INCREASED LANE MILEAGE ON TRAFFIC FATALITIES

Lauren Hawes

Governor's School for Science & Mathematics

Mentor: Christopher Mothorpe, College of Charleston

The purpose of this research is to identify the correlation between road expansion and traffic fatalities. To understand this we used the 20 counties surrounding Atlanta as a case study into this problem. In order to do this we collected data from government sources about fatal accidents in this area as well as road expansion. The logic model and the binary system were used to determine the relationship between accidents and expansion. This model was used to determine a trend line for accidents and lane expansion. We found that there was a correlation between lane expansion and fatal accidents. It was not a strong correlation, but it did exist.

#### REDESIGNING THE CANINE WHEELCHAIR

Katherine Hayden

Center for Advanced Technical Studies

The most common issue from the traditional design of the canine wheelchair arises with the discomfort caused by the wheels. The wheel currently used on wheelchairs only allows for 2 degrees of freedom--forwards and backwards--and usually are bulky and oversized. This, therefore, evokes unsafe and unstable conditions for the dog by making it easy to overturn or get caught in corners. Although disabled dogs should not be left unattended whilst in the wheelchair, if they are and the cart overturns, it could potentially exacerbate the dog's existing medical condition. By replacing the wheels on a canine wheelchair with ball casters, these problems are resolved. Ball casters allow for a more fluid, natural movement of the dog's hips, allow movement in virtually every direction, and are functional on most surfaces since the ball is made of stainless steel. Key features also include a padded chassis for maximum comfort, chest and pelvic harnesses for support, and detachable stirrups for paralyzed (paraplegic) dogs.

#### THE DIFFERENCE IN AMOUNT OF ETHANOL PRODUCED BY PORTOBELLO AND SHIITAKE MUSHROOM CELLULOSE

Riley Haywood and Noah Schumacher

Heathwood Hall

Two common types of mushrooms, the Portobello and Shiitake mushrooms, were used to see which mushroom produced more cellulosic ethanol. The hypothesis was if the enzyme Cellobiase reacted with cellulose from Shiitake and Portobello mushrooms, then Portobello would produce more ethanol. The results of this study did support the hypothesis. In this study Portobello mushrooms produced almost 20 times more ethanol. A Bio Rad Labs Biofuel Enzyme Kit was used to measure the amount of p-Nitrophenol produced by these mushrooms. p-Nitrophenol was then used as an indicator of a proportional production of ethanol. This result means that there is a potential to use Portobello mushrooms to process cellulosic ethanol for possibly making fuel for vehicles in the future.

#### THE EFFECT OF DIFFERENT COLOR LIGHT AFFECT THE GROWTH OF PLANTS.

Wenlan He

Heathwood Hall

The purpose of this experiment was to find out how different color of lights affect the growth of plants. Six of different colors lights were set for the plants, and therefore the results would shows which light would produce the highest plants, which means let the plants absorbs the most lightning energy. The subjects used in this experiment were under the color gel, and let the subjects grew for a month, and compare the data on different height of the plants. The hypothesis of this experiment was, the plants under purple light would have the highest length in. The results of this experiment didn't support the hypothesis. In conclusion, this experiment will help the farmers, by using which light would make plants grew well.

#### THE EFFECTS OF ADDING DIVOTS TO THE HULL OF A BOAT ON ITS DRAG

John Heaton

Heathwood Hall

The purpose of this experiment is to identify the effects on the drag of a boat caused by adding small divots across the hull. This experiment was performed by having two boats made out of metal using the same proportions, one with small divots placed evenly across the hull and the other having a flat hull. These boats were then connected to a string that ran from the boat to a weighted pulley that would pull the connected boat through water. The amount of time it took for the weight to hit the ground was measured using a stopwatch. The speed of the weight falling would correlate to the speed of the boat moving through water. The faster the weight fell, the faster the boat traveled. The speed of the boat would be determined by how well

it traveled through the water. This means that a boat with a lower drag would go faster than a boat with a higher drag. Although the ANOVA analysis of the data suggests variation between the two data sets, the difference was not enough to be considered statistically significant. Thus the results of the experiment support my null hypothesis, Adding Divots to the hull of a boat does not seem to decrease drag.

#### IDENTIFICATION OF ZEBRAFISH CARRYING THE ZMYM2 AND ZMYM3 MUTANT ALLELES

Samuel Helms

Governor's School for Science & Mathematics

Mentor: April Delaurier, University of South Carolina Aiken

Potocki Shaffer syndrome is a very rare disorder that occurs in humans. There are many side-effects of the disorder, but perhaps the most profound symptom is some form of craniofacial abnormality. Typical abnormalities in the skull structure are microcephaly, brachycephaly, and midfacial hypoplasia. These craniofacial abnormalities are caused by the haploinsufficiency of the PHF21A gene. This gene is similar to the zebrafish PHF21A ortholog. The research was done to create a generation of zebrafish that had the *zmym2* or *zmym3* mutant allele present. These two genes are known to be present in the *phf21a* complex where the PHF21A gene is located. This means that these two mutated alleles could be responsible for craniofacial abnormalities as well. This research was done by crossing zebrafish and then conducting a DNA extraction using their embryos. PCR was then used to amplify the DNA, and a T7E1 assay was run to see if the fish had the mutant allele. An F1 zebrafish carrying the *zmym2* mutant allele was identified; however, an F1 zebrafish carrying the *zmym3* mutant allele was not. This means that future research can create zebrafish that are heterozygous for the *zmym2* mutant allele to see if there are any noticeable craniofacial abnormalities. If there are abnormalities, then this gene would be responsible for craniofacial development just as the PHF21A gene is.

#### THE EFFECT OF ULTRASOUND ON *E. COLI* DECONTAMINATION

Noah Hook

Spring Valley High School

Water pollution is an enormous problem in many third world countries and even in some first world countries. With many people living without fresh and clean water due to dangerous bacteria, there are new ideas emerging trying to decontaminate infected water. One of these ways is the use of ultrasonic waves, which are sound waves above 20,000 hertz. The purpose of this experiment was to test whether higher frequencies of ultrasound could more effectively kill *E. coli*. To test this, 15 beakers of water were inoculated with K-12 strain *E. coli*. Then each of the beakers was assigned a group, either 1, 2, or 3. Each group was exposed to a different frequency of ultrasound: group 1 was the control, group 2 was 1 megahertz, and group 3 was 3.3 megahertz. After exposure, 2 petri dishes were inoculated from each beaker, and the bacteria were allowed one day to grow. Bacteria were then counted in quadrant four and the data were recorded. The results showed that there was statistical significance when it came to group 3 by the use of an ANOVA ( $F(2,27) = 5.05$ ,  $p = 0.014$ ) and a Tukey test. The p-value was shown to be 0.014, which is less than the alpha value of 0.05. This suggests significance; therefore, the null hypothesis was rejected. In conclusion, the results suggest that the higher frequencies of ultrasound destroy bacteria more effectively than lower frequencies of ultrasound.

#### IMPACT OF ENVIRONMENTAL EDUCATION ON COMPOST LEVELS AND LANDFILL WASTE REDUCTION AT CHAPIN HIGH SCHOOL

Matt Hooker

Chapin High School

Food waste is a growing problem in the United States where roughly 40% of edible food is wasted annually in American homes. A majority of this waste is post-consumer because the producers are extremely efficient in affluent countries like the U.S. Many people don't know the implications of wasting food. The option of composting was not even available in Chapin's cafeteria until this research began. This waste becomes a nutrient rich soil known as "humus" which is extremely effective for growing crops. This study introduced a composting option into the cafeteria and measured how the students composted daily over a two-week span. After these two weeks, an educational push was initiated which involved posters and videos to introduce the students to composting and the rules and benefits that it entails. The food waste was measured, in pounds, each day for several weeks after the educational push. The study found that an average of 5 pounds of food was composted before the educational push and 8 pounds of waste after. This research was statistically relevant and showed that students composted more waste after they were educated on the topic. Composting on the school level can drastically improve environmental preservation.

GENERATION OF A YEAST OVEREXPRESSION PLASMID FOR PURIFICATION OF THE IRON TRANSCRIPTION  
FACTOR AFT2

Harrison Howell  
Governor's School for Science & Mathematics  
Mentor: Caryn Outten, University of South Carolina Columbia

Iron is central in many essential intracellular processes, and as a result, balancing its level is crucial. Over two billion people suffer from iron deficiency, decreasing their overall health and leading to illnesses such as anemia. Conversely, too much iron can lead to diseases such as hemochromatosis. Understanding the molecular mechanics of iron homeostasis is the key to alleviating many of the diseases associated with improper iron regulation. Using the model eukaryote *S. cerevisiae*, many of the basic pathways in iron homeostasis have been uncovered. In yeast, iron absorption and accumulation is regulated by the Aft1 and Aft2 transcription factors that control the expression of the genes collectively termed the iron regulon. In low-iron conditions, the Aft2 factor activates gene expression to increase intracellular iron levels. To better understand the molecular mechanism used by Aft2 to regulate gene expression, attempts have been made to express and purify the full-length Aft2 protein in *E. coli* for biochemical analysis. This problem was addressed through the successful construction of an expression vector containing the AFT2 full-length gene using the Gibson Assembly protocol. This new expression plasmid will allow the expression and purification of Aft2 directly from yeast. Large amounts of the purified protein will enable exploration of the DNA and iron-binding properties of this iron-responsive transcription factor at the molecular level.

THE ASSOCIATION BETWEEN ADOLESCENT AMBLYOPIA AND THE PREDISPOSITION OF INTROVERSION OR  
EXTROVERSION IN A HIGH SCHOOL POPULATION

Bianca Huet  
Chapin High School

Amblyopia is the medical term used when the vision in one of the eyes is reduced because the eye and the brain are not working together properly. The eye itself looks normal, but it is not being used normally because the brain is favoring the other eye. This condition is also sometimes called lazy eye. The National Eye Institute demonstrates that amblyopia is corrected most effectively at a younger, adolescent age, affecting approximately 2 to 3 out of every 100 children, however there are a limited number of correction treatments for this condition. An observational survey was administered to a selection of randomized upperclassmen at a selected high school in order to identify whether there is an association between the specified personality traits of introversion and extraversion and a previous condition of amblyopia diagnosed as an adolescent. Overall, the majority of students with previous conditions of amblyopia unexpectedly had extroverted tendencies, but an association nonetheless. The study being conducted will demonstrate a newfound importance in that it will shine light on how the condition of amblyopia, and even further what correctional treatment a patient receives, affects the personality traits of patients with a current or previous condition of it. This will further illustrate in what direction correctional treatments should take. The study proves an association between the two, and this project was prompted in hopes that researchers will have a better idea of the long-term impact of the condition of amblyopia and its prescribed correctional treatment.

HIERARCHICAL STRUCTURE WITH PERSISTENT MICELLE TEMPLATE (PMT)

Jamaal Jacobs  
Governor's School for Science & Mathematics  
Mentor: Morgan Stefik, University of South Carolina Columbia

Polymers with both a hydrophobic (repelled by water) and hydrophilic (attracted to water) ends form spheres known as micelles whenever introduced with water. Each polymer has an optimal micelle size that gives the polymer a wide range of properties. These properties range from being more bendable to being more elastic. This experiment used Poly-ethylene oxide-block-hexyl acrylate with the hydrophobic and hydrophilic ends in order to find its micelle size, which was done by adding multiple amounts of water and agitating the samples at different intervals. This experiment found that the micelle size of the polymer Poly-ethylene oxide-block-hexyl acrylate had a micelle size between 10 and 1000 nanometers, and that the micelle size can be found by adding some value between 20 and 100 microliters of hydrochloric acid.

A NOVEL APPROACH IN THE EXTRACT OF *MELALEUCA ALTERNIFOLIA* AS A POTENTIAL TOPICAL TREATMENT  
OF CUTANEOUS *ASPERGILLUS USTUS* INFECTIONS

Isak Jatoi  
Spring Valley High School

Primary cutaneous aspergillosis (PCA) is a serious concern for immunocompromised patients, with poor prognosis and high rates of dissemination and recurrence. The current treatment methods for PCA, surgical debridement and systemic antifungal therapy, are often ineffective, even when used in conjunction with one another. Infections by *Aspergillus ustus* are particularly threatening, as *A. ustus* is resistant to many currently used antifungals. Tea tree oil (TTO) is a natural extract from the Australian shrub *Melaleuca alternifolia*, and a large body of evidence supports its antimicrobial activity. As such, TTO was tested in vitro as a potential antifungal agent against *A. ustus*. A broth microdilution assay was conducted for 48 hours using the concentration range of 0.25% to 16% TTO, along with positive growth and negative growth controls, in order to determine the minimum inhibitory concentration (MIC). Afterwards, a spectrophotometric time-kill assay was conducted using the MIC,

2 x MIC, and 0.5 MIC values, with aliquots of the TTO solutions taken at 0, 24, and 48 hours. The MIC was determined at 4% TTO from the broth microdilution assay, with a Kruskal-Wallis test displaying statistical significance,  $X^2(8, N = 8) = 60.375$ ,  $p < 0.0001$ . Additionally, a post hoc Dunn test found a significant difference between 4% TTO and the positive growth control ( $p = 0.001$ ). The time-kill assay exhibited a decline in optical density for the 8% TTO between 0 and 48 hours. However, the 2% and 4% TTO solutions displayed a resurgence in growth after an initial decrease in optical density at 24 hours. Overall, the results demonstrated antifungal efficacy of TTO, while also indicating that TTO loses potency after prolonged periods of use at lower concentrations. These results and others further warrant the use of TTO as a topical agent for PCA.

#### THE EFFECTS OF POLYCYCLIC AROMATIC HYDROCARBONS ON THE PRODUCTION OF LACTATE DEHYDROGENASE IN MCF-7 CELLS

Sunjay Jayaram

Dutch Fork High School

Mentor: Samir Raychoudhury, Benedict College

PAHs are compounds that are toxic to human beings that is found in soot, tar mineral oils and many other places in the environment. An abundance of research has been conducted on PAHs as potent carcinogens for many types of cancers. The subject of this study is how PAHs react in comparison to other chemicals (Tamoxifen and Estradiol) in MCF-7 breast cancer cells. The experiments conducted involve the effect of high and low doses of PAHs in relation to the MCF-7 cell line of breast cancer cells. These doses will be compared in relation to both controls as well as Tamoxifen, a competitive inhibitor to estrogen receptors in MCF-7. If a cell is damaged, it will release lactate dehydrogenase, so this will be the dependent variable to measure cell damage. The hypothesis is that when the high and low doses of PAH are exposed to MCF-7 cells, they will release higher amounts of LDH as opposed to Tamoxifen and the controls tested.

#### SYNTHESIS AND EVALUATION OF D-AMINO ACID SUBSTITUTED CYCLIC PEPTIDE INHIBITORS OF LYSINE SPECIFIC DEMETHYLASE 1

Tyreek Jenkins

Governor's School for Science & Mathematics

Mentor: Patrick Woster, Medical University of South Carolina

Lysine specific demethylase 1 (LSD1) is an enzyme that removes methyl groups from mono- and dimethylated histone 3 lysine 4 (H3K4), resulting in gene silencing. LSD1 became a valid cancer target because its overexpression has been observed in various human cancers and correlated with aberrant silencing of tumor suppressor genes. To date, a handful of small molecule—and peptide based—inhibitors mimicking the structure of the natural substrate (H3K4) displayed good in vitro inhibition activity toward LSD1. The present project has the aim of synthesizing, using the standard N-(9-Fluorenylmethoxycarbonyl-O-tert-butyl) (Fmoc/t-Bu) solid phase peptide synthesis procedure and evaluating the biological activity, using the Cell Titer 96® Aqueous One Cell Proliferation Assay, in which each L-amino acid is replaced by its stereoisomer D-amino acid. This approach is based on the fact that D-amino acids can stabilize certain reverse  $\beta$ -turns or destabilize  $\alpha$ -helices, thus, providing insights about how a conformational constraint in the peptide affects the binding affinity toward the LSD1 enzyme. Specifically, the derivative is a cyclic peptide where the L-proline (Pro16 in the sequence) was replaced by D-proline. By replacing L-proline with D-proline, it is expected to identify the conformational features of the cyclic peptide that affect the in vitro LSD1 inhibition activity and the antitumor activity on cancer cell lines. The D-proline peptide showed a 38.1% growth inhibition on human anaplastic carcinoma cell lines at a concentration of 5mM, which indicated low antitumor activity. Future work include synthesis and evaluation of additional D-amino acid analogues along the peptide sequence.

#### EXPLORING POSSIBILITIES OF AN ADAPTIVE NEBULIZER SYSTEM FOR IMPROVED AND EFFICIENT AEROSOL THERAPY: A COMPREHENSIVE EXPERIMENTAL STUDY

Ishita Kapoor

Spring Valley High School

Aerosol therapy is the most common respiratory treatment for lung related diseases, where the drug is atomized to micro particle size allowing it to reach different areas of the respiratory tract. Many delivery devices exist, but nebulizers, despite their low efficiency (<20%), are still the most common method of delivering medication to children or patients in critical care. The most common respiratory therapy standard has set guidelines that when the nebulizer sputters, it marks the end of treatment, not realizing that sputtering is a result of many external factors in nebulizer and leads to wasted drug and high cost. This research is aimed at delaying the start of sputtering thereby improving consistency in nebulization for effective aerosol treatment and creating an adaptive timed drug delivery system. Modifications included the addition of a baffle and creating hydrophobic surface of nebulizer interior walls, when tested with 3cc Sodium Chloride solution showed a statistically significantly difference in delaying sputtering time thereby improving nebulizer consistency and lowering residual volume  $F(12,52)=135.75$ ,  $p < 0.001$  as compared to unmodified nebulizer. The second part of this project validated the concept of dynamic nebulization by creating a prototype using ultrafast sensors that control the aerosol generation only during inhalation. This concept is also able to provide quantifiable data on tidal volume of breathing cycle and effective treatment breaths. Ultra-fast sensors that were used in this prototype leads to the possibilities of shifting from current and inaccurate aerosol therapy standard measured as treatment time to a more accurate and quantifiable standard - number of breaths,

while decreasing the treatment cost. As a next step, possibility of commercialization will be explored under guidance from Medical University of South Carolina.

#### THE EFFECT OF CORROSION ON THE ANTIBACTERIAL ABILITY OF COPPER, BRASS, ALUMINUM, AND STAINLESS, STEEL

Garrett Kaufman  
Spring Valley High School

Due to an increase in antibiotic resistant strains of bacteria, new methods for killing bacteria without the use of antibiotics and caustic chemicals are being sought out. Research has shown that some metals can be used as a way to kill bacteria on contact. This experiment was designed to see how well copper, brass, aluminum, and stainless steel were able to kill bacteria after acid corrosion. This was intended to mimic extended contact with human sweat from handling. It was hypothesized that metal subjected to corrosion would be less effective against bacteria than metal that had not been corroded. Twenty metal squares of each metal type were used measuring 0.635cm on each side. Half of each group was randomly selected for corrosion. Afterwards, all metal squares were randomly assigned to 16 petri dishes with 5 squares per petri dish, and each dish was covered in *E. coli*. After 48 hours of incubation at 37°C, the zones of inhibition around the metal squares were measured. The results were analyzed with an ANOVA at alpha equal to 0.05. This ANOVA ( $F(7,67) = 2.22, p = 0.044$ ) showed that the results were significant, but a Scheffe test was not powerful enough to determine with certainty the locations of these differences. Based on the values gathered from the Scheffe test it can be concluded that the hypothesis was not supported. The biggest differences shown in this test indicate that corrosion generally increases antibacterial ability of the metals tested with the exception of copper.

#### THERMOELECTRIC GENERATORS UTILIZING A COOLER

Joshua Keller  
Center for Advanced Technical Studies

The battery life of a typical cellular phone tends to decrease rapidly when exposed to extreme temperatures. In these situations of extreme temperature, a power source simply may not be available. If a cooler can be modified to provide constant power based on the temperature differential inside and outside the cooler, then a phone or other small electronic device can be charged and extend user battery life. By placing 6 Thermoelectric Generators on the surface of the cooler a dramatic temperature gradient will allow energy to be produced (via the Seebeck Effect). The dimensions of the Thermoelectric Generators are to be cut into the cooler followed by placing the Thermoelectric Generators into the cut-out areas and securing the devices. The wires from the Thermoelectric Generators will be connected in series on the outside of the cooler with wire nuts. The results to date have shown that the Thermoelectric Generators produced a consistent amount of power or DC voltage. The data collected showed that a more efficient Thermoelectric Generator will be needed to charge a portable phone. This newly developed product has many practical applications and could be used in a beach or pool setting whereby creating a mobile power source in the absence accessible power. After initial prototype development, a secondary goal is to power a cooling fan in a cooler to make the cooler stay cold for extended periods of time without addition of ice.

#### THE EFFECT OF VARIOUS TYPES OF DISTRACTIONS IN A TESTING ENVIRONMENT ON THE PERFORMANCE OF ACADEMIC TASKS

Gloria Kim  
Spring Valley High School

With the invention of smartphones and mass media, distractions are becoming more prevalent in students' lives more than ever. Students believe they can multitask between engagement in social media and academics. However, this results in their academics suffering negative repercussions. Findings from this study could emphasize the importance of limiting distractions in work environments and could determine what types of distractions should be avoided depending on the academic work. It was hypothesized that text messaging would have the greatest impact on test scores, especially those in mathematics. Subjects were randomly distributed into one of three academic tasks (SAT Reading, SAT Math, and SAT Vocabulary) and performed their designated task in five types of testing environments: no distraction, music (without lyrics), music (with lyrics), text messaging, and Internet/social media. Responses were scored using the corresponding answer keys and were compared. At  $\alpha = 0.05$ , the three ANOVA tests for each academic task indicated that there were no statistically significant differences between the scores of each testing environment for any subject, ( $F(4,45) = 1.2326, p = 0.3106$ ), ( $F(4,45) = 0.5453, p = 0.7033$ ), and ( $F(4,45) = 0.3152, p = 0.8663$ ). Therefore, the hypothesis was not supported. In conclusion, the impact of text messaging on academic performance is no greater than the impact of other distractions such as music and social media.

#### THE EFFECT OF POLYINOSINIC:POLYCYTIDILIC ACID ON THE HEMATOPOIETIC STEM CELL CYCLE

David Kindervater  
Governor's School for Science & Mathematics  
Mentor: Andreas Trumpp, German Cancer Research Center

Interferon treatment has become a well-established form of therapy, in collaboration with chemotherapy and radiation, in the treatment of numerous cancers. Interferon is a signaling protein which, when secreted, stimulates the cycling of

Hematopoietic Stem Cells (HSCs), leading to the generation of immune cells capable of attacking tumors and metastatic niches. Interferon is secreted by host cells in the presence of pathogens, including viruses and tumor cells. But Interferon treatment is accompanied by numerous side effects. The aim of this project is to test Polyinosinic:polycytidilic acid (poly(I:C)), a synthetic double-stranded RNA, as an alternative to interferon treatment. Mice were given mammary fat pad injections of EYFP-tagged MDA-MB-231 carcinoma cells, and monitored for bioluminescence until well-developed metastases were observed in the lungs. The mice were then injected with 200  $\mu$ L of poly(I:C), and sacrificed after 24 hours. Bone marrow, blood, and lungs were extracted for immunofluorescence staining and Fluorescent Activated Cell Sorting (FACs) analysis. FACs analysis results indicated that mice with immune deficiencies showed drastic increases in the number of differentiated immune cells and HSCs in the latter stages of the cell cycle (SG2M) when treated with poly(I:C), supporting previous research on poly(I:C) and its effect in mouse models.

#### METHANE PRODUCTION FROM MICROBIAL FUEL CELLS

Zachary Kochert

Center for Advanced Technical Studies

This project is being conducted to determine whether or not a Microbial Fuel Cell and a Methane digester can be combined into one unit in an efficient manner. If a Microbial Fuel Cell and a Methane digester can be combined into a single unit then more energy can be gathered from one source. Methods for researching this idea are first designing a unit that makes it easy to change different variables. This will make it possible for me to find the specific settings that generate the most methane and the most voltage with the same fuel. So far this has been accomplished by first making a fuel that is near to a 30:1 carbon to nitrogen ratio then pouring that in around an anode and a cathode. Then the unit is sealed so that it will begin to generate methane which is stored in a separate connected container. Once the methane has stopped being created the unit is opened up so that electricity can be generated. The result of this process is that methane is generated when the unit is sealed and electricity is generated when the unit is open. So far in the project the methane production is low but the electricity production is average or high. So far in this project it has been proven that Microbial Fuel Cells and Methane Digesters can be combined into one unit. This shows that methane and electricity can be generated from one unit and with one fuel.

#### THE EFFECT OF ZEOLITES ON THE PERCENT TRANSMITTANCE OF LEAD CONTAMINATED WATER

Christopher Kong

Spring Valley High School

Throughout the past 50 years, water contamination has negatively affected the environment and its organisms. Heavy metals, such as lead, are one of the most common contaminants of water. Research was conducted to find a potential solution to treating lead contaminated water using zeolites: an aluminosilicate, crystalline structure. The purpose of this experiment was to determine if using larger amounts of zeolites would treat and purify the lead contaminated water more effectively than in smaller amounts. It was hypothesized that as the amount of zeolite increases, the percent transmittance would increase for the post-treated solution. Treatment was carried out by pouring a lead contaminated solution, composed of distilled water and lead (II) oxide, through different masses of zeolites which was then tested afterwards to measure the treatment's effectiveness. A one-way ANOVA at  $\alpha = 0.05$  found that control group ( $n = 30$ ,  $M = 63.29\%$ ,  $SD = 12.63\%$ ), the 1.00 g ( $n = 30$ ,  $M = 84.36\%$ ,  $SD = 9.53\%$ ), the 1.75 g ( $n = 30$ ,  $M = 88.00\%$ ,  $SD = 6.71\%$ ), and the 2.50 g ( $n = 30$ ,  $M = 90.78\%$ ,  $SD = 12.66\%$ ) were statistically significantly different ( $F(3,116) = 41.10$ ,  $p < 0.001$ ). A post-hoc Tukey test indicated that the test values for the 1.00 g ( $n = 30$ ,  $M = 84.36\%$ ,  $SD = 9.53\%$ ), the 1.75 g ( $n = 30$ ,  $M = 88.00\%$ ,  $SD = 6.71\%$ ), and the 2.50 g ( $n = 30$ ,  $M = 90.78\%$ ,  $SD = 12.66\%$ ) all had statistically significant differences to the control group ( $n = 30$ ,  $M = 63.29\%$ ,  $SD = 12.63\%$ ), the 1.00 g ( $n = 30$ ,  $M = 84.36\%$ ,  $SD = 9.53\%$ ). The hypothesis was not supported; as the data indicated that there were statically insignificant differences between the experimental groups excluding the control. However, the data does indicate that zeolites are an effective method in treating lead contaminated water.

#### GROWTH AND DEVELOPMENT IN THE RUSSIAN FEDERATION BETWEEN 1990 AND 2014

Johnathan Kovarna

Governor's School for Science & Mathematics

Mentor: Chandini Sankaran, University of South Carolina Columbia

Creating a strong economy and increasing social well-being are important primary steps in forming a good country. A country with a strong economy and a good level of social well-being can shift their focus onto other issues that affect certain groups within the country. Because of this, it is important that we discover how to help countries make their economies strong, which we can do by observing how countries with weaker economies grow and develop. This research project looks at the economic growth and development of the Russian Federation from 1990 to 2014, to see how they have developed, and later research will focus on the policies that led to this growth. Data was collected from the World Bank Organization, and then graphed to see how certain statistics have changed between 1990 and 2014. Research has concluded that Russia has developed a strong economy since 1990, and has greatly increased some important factors for quality of life for its citizens. Since Russia has been determined to have developed a strong economy, further research must be done to determine what policies and reforms led to this, so that they may be implemented in other countries that have a weak or unstable economy.

A COMPARISON OF THE TOTAL POLYPHENOLS IN *DAUCUS CAROTA*, *CYANOCOCCUS*, *CITRUS SINENSIS*,  
*CITRUS LIMON*, *ACTINIDIA DELICIOSA*, AND *MANGIFERA INDICA*

Vikram Kumar  
Spring Valley High School

Degenerative diseases, as well as bacterial infections are caused by oxidative stress, and are a huge problem in the world. Antioxidants are needed to safely balance the harmful effects of free radicals without causing any damage to the body. Bioactive compounds, such as polyphenols and polyphenol derivatives, have powerful antioxidative abilities and can treat and prevent degenerative diseases. Many common edible plants, such as carrot, blueberry, lemon, kiwi, orange, and mango contain polyphenols. Polyphenols can be measured by creating an aqueous extract. This can be done by boiling down each fruit or vegetable in water. 5 mL of the resulting extract were mixed with 5 mL of Folin-Denis reagent and heated on a hot plate for a minute. The resulting solution was transferred into a cuvette and placed into a spectrophotometer that was calibrated to a blank of Folin-Denis reagent. The extracts were measured for absorbance at a wavelength of 450 nm to determine relative polyphenol levels. An ANOVA test at  $\alpha = 0.05$  ( $F(5)=118.651$ ,  $p > 0.001$ ) was used to test the significance of the results. Since the ANOVA test returned a p-value of less than 0.001, the data is significant because 0.001 is less than the alpha value. This means the null hypothesis that there is no difference between the extracts is rejected, as there were significant differences in the polyphenol levels. The hypothesis that the darkest colored extract, in this case blueberry, would have the highest level of polyphenols was also supported by the data.

EXPOSURE RESPONSE AND NOISE IN A DIGITAL IMAGING SYSTEM

Caitlin Kunchur  
Dutch Fork High School

Pictures represent scenes by recording different values of brightness and color at different locations. A digital camera has a sensor with many pixels. Each pixel has stored electric charge that leaks out through a photodiode when light falls onto it. The amount of leaked charge indicates the exposure which corresponds to the amount of light energy that hit the pixel. Variations in exposure for the same light energy represent noise. Besides the scene's luminance (brightness), exposure and noise depend on the camera settings of shutter speed, aperture, ISO, and resolution (megapixels). The first experiment's goal was to see how accurate the proportionality between the exposure and light energy was. The second experiment's goal was to test the principle of reciprocity which states that the same exposure can be achieved with different combinations of shutter speed and aperture as long as the same light energy is maintained. The third experiment's goal was to see how noise is affected with an increase in ISO. The last experiment's goal was to see how noise is affected with changes in resolution. The experiments used a Canon digital camera and a software called GetRGB which extracts the RGB values for every pixel in the picture. For each color value, the mean and standard deviation were calculated for all the pixels which reflected the exposure and the noise respectively. The following conclusions were found: 1) Even this basic digital camera proved to have a more linear exposure response and reciprocity than typical film. 2) As expected, the noise increased with ISO due to a higher amplification for a smaller amount of charge. 3) As expected, a decrease in the number of pixels resulted in less noise due to the merging of pixels and consequently more collected light energy and fractionally less variations. This contradicts the common misconception that more pixels are always better.

RAPID PROTOTYPING OF COMPACT BONE OSTEONS

Faisal Lachab  
Governor's School for Science & Mathematics  
Mentor: Esmail Jabbari, University of South Carolina Columbia

In the United States alone, there are 6.3 million bone fractures per year. The healing process can take weeks and even months after surgery. Therefore, synthetic bone can be used as a replacement until recovery of the damaged bone. Compact bone is primarily made of osteons, and hydroxyapatite is a paste that mimics real bone material. The aim of this project was to fully develop a synthetic osteon prototype from hydroxyapatite that could be produced efficiently while still retaining the properties of a functional bone. This osteon model would have to be biocompatible and osteoconductive with high tensile strength. First, a model of an osteon had to be designed in Fusion 360 and sent to the 3D printer. This step was followed by synthesis of paste-like hydroxyapatite, which was press-injected into the osteon mold and burned off to leave just the intact osteon made of hydroxyapatite and subjected to various temperatures to determine the ideal combination for the best osteon. Results indicated that the best osteon was produced when the mold was subjected to 325°F for 1 hour, followed by 425°F for 2 hours, and 475°F for 1 hour. In the future, tests would have to be performed on the rapidly produced osteons in order to ensure their strength, and degradation rates, since the synthetic osteon is only supposed to last long enough to allow for the new bone to grow in its place.

THE POLYMERIZATION OF N-VINYLPYRROLIDONE IN PHENYLETHYLENE BIS-UREA MACROCYCLES

Julia Ladson  
Governor's School for Science & Mathematics  
Mentor: Linda Shimizu, University of South Carolina Columbia

New ways to polymerize the monomer n-Vinylpyrrolidone in a Phenylethylene Bis-urea macrocycle were investigated. The goal was to shine ultraviolet light on it to activate it, therefore initializing the polymerization process. The polymerization of

n-Vinylpyrrolidone has been done before, but not in this macrocycle vessel, and with hydrogen peroxide as an initiator to start the polymerization process. Because the monomer in use is commonly used in food agents, I didn't want to use hydrogen peroxide, an oxidizer, in it. They are dangerous for the human body. We decided to use ultraviolet light instead. We tried three different processes to load n-Vinylpyrrolidone in the macrocycle. For the first process, we made a solution of N-Vinylpyrrolidone and acetonitrile in a container. Then we put Phenylethylene crystals in. That soaked for 5 hours. We took a TGA and UV vis of the crystals and it loaded at 75%. Next, we used a more direct loading. n-Vinylpyrrolidone was put in the macrocycle. We shined light on it and let it soak for 6 hours. We ran a TGA of the crystals and found it loaded at 50%. It didn't load well, because the solvent used in filtering dissolved some of the monomer out of the macrocycle. Lastly, we used direct loading. We put n-Vinylpyrrolidone in the macrocycle, and shined light on it. It sat for 8 hours, filtered, and we took a TGA and UV vis of it. The macrocycle consumed all of the monomer, and the monomer became a polymer.

#### UPPER BOUND ON THE BURNING NUMBER OF GRAPHS

Max Land

Dutch Fork High School

Mentor: Linyuan Lu, University of South Carolina Columbia

The burning number of a graph was introduced by Bonato-Janssen-Roshanbin [Lecture Notes in Computer Science 8882 (2014)]. It is used to model the spread of contagion processes over contact networks. For example, many graphs are used to model social connections on facebook or a population of trees in the wilderness. The burning number of a graph would estimate the amount of time it would take information to travel among facebook friends, or the time it would take for a virus to infect an entire population of trees.

In their paper, Bonato-Janssen-Roshanbin considered a graph process which they called burning. At the beginning of the process, all vertices of a graph are unburned. During each round, one may choose an unburned vertex and change its status to burned. At the same time, each of the vertices that are already burned, will remain burned and spread to all of its neighbors and change their status to burned. A graph is called k-burnable if it can be burned in at most k steps. The burning number of a graph G, denoted by  $b(G)$ , is the minimum number of rounds necessary to burn all vertices of the graph. They conjectured the burning number of any connected graph G on n vertices is at most the square root of n, denoted by  $\sqrt{n}$ . The previously best known upper bound was roughly  $1.298\sqrt{n}$ . In this paper, we improved the upper bound to roughly  $1.225\sqrt{n}$  by a novel method of induction.

#### THE EFFECT OF MUSIC GENRE AND VOLUME ON A PERSON'S HEART RATE AND REACTION TIME

Julia Lauterbach and Kate Willhide

Heathwood Hall

In this research project, the effect of music genre and volume on a person's heart rate and reaction time were examined on 24 driving age participants. The purpose of this experiment is to investigate the effect of music on a driver's ability to stay focused. It was hypothesized that higher volumes and more intense music would lead to increased heart rates and reaction times. The students performed three trials on each subject, over a span of a couple days, with the same genre of music so that all trials could be averaged and analyzed using an ANOVA test. Three different volumes were tested with a different song used for each volume to see if any changes would occur in heart rate or reaction time. The researchers found that in the pop genre there was no significant difference in heart rate between volumes, however, there was a statistically significant difference in reaction time. There was no statistically significant difference in heart rate between volumes, or reaction times when reviewing the data from the Hard Rock subjects. Concerning the classical genre, there was no statistically significant difference in heart rate between volumes or in reaction time, though the numbers follow the same trend as pop and hard rock. In conclusion, the researcher's hypothesis was not fully supported for all genres and volumes. In most cases, the heart rate of the test subjects did not increase with volume or a more intense genre.

#### A NEW MOUSE MODEL OF HUMAN PROSTATE CANCER DRIVEN BY MYC OVEREXPRESSION AND PTEN LOSS

Brantley Leapart

Governor's School for Science & Mathematics

Mentor: Charles Bieberich, University of Maryland Baltimore County

Most forms of prostate cancer depend on the presence of androgen, a class of male hormones, which binds to androgen receptors located on the surface of the prostate cells to support growth. Androgen-independent prostate cancer occurs after the disease has progressed such that it no longer relies on the presence of androgen, thereby making traditional treatments, including hormone deprivation therapy, ineffective. The goal of this project was to determine the in vivo growth characteristics of two newly-derived androgen independent mouse prostate cancer cell lines developed from a genetically engineered mouse model. Clonal cell lines from liver and lymph node metastatic sites in the BMPC mouse prostate cancer model (FVB/N background) were injected subcutaneously into athymic nude mice (Balb/c background) and FVB/N mice. Growth curves of xenograft tumors located in the immunocompromised athymic nude mice and FVB/N mice were determined by daily measurements of tumor size. The study showed that the cell line derived from the liver metastasis produced xenograft tumors in the athymic nude mice, as well as allograft tumors in the FVB mice. These data suggest that allografts of metastatic BMPC cell lines grown in immunocompetent FVB mice are a viable option for pre-clinical trials of treatments for androgen independent prostate cancer.

## THE EFFECTS OF SIMULATED ACID RAIN ON THE GROWTH OF *LEMNA MINOR*

Isaac Lee  
Spring Valley High School

Acid rain is a growing problem with the continued industrialization of the better part of the world, especially in countries with little to no environmental regulation. The unnatural acidity can kill off local flora and as a result, disrupt the surrounding ecology. The purpose of the study is to study the interaction of different pH's of simulated acid rain with *Lemna minor*, and see how increased pHs affect and damage duckweed. The hypothesis was that the 4.0 pH simulated acid rain would be the most damaging to the duckweed. Varying pH's of simulated acid rain, which contained a 7:3 mix of nitric and sulfuric acid were added to an environment which contained duckweed. The amount of growth was measured for the duckweed as a way to gauge the sustainability of an aquatic environment after a spike in acidity. The mean differences of each treatment was analyzed using ANOVA at  $\alpha = 0.05$  level. There was statistical differences among the treatments at  $F(4, 34) = 6.46$ ,  $p = 0.001$ . Results also indicated that the 4.0 pH treatment was the most damaging.

## VERIFYING HIGH-THROUGHPUT METHODS FOR DETERMINING MECHANICAL PROPERTIES OF UV CURED POLYMERS

Top Lee  
Governor's School for Science & Mathematics  
Mentor: Jason Hatrick-Simpers, University of South Carolina Columbia

The focus of this research is to create and test a high-throughput method for tensile-testing a large number of polymer samples cured with ultraviolet (UV) light. The method creates 27 separate tensile samples in a short amount of time relative to other known methods of tensile testing. Full trays of 27 thiol-ene polymer samples were synthesized by reacting Trimethylolpropane tris(3-mercaptopropionate) with Trimethylolpropane triacrylate, and a photo initiator, 2,2-Dimethoxy-2-phenylacetophenone. The hypothesis for this research was that each sample could have a different variable while keeping the same statistical validity across each one. Individually, each of the samples does not have enough statistical validity to create 27 different tensile samples. When merged into groups of five or six based on location on a Teflon tray, standard deviation is 7% instead of over 100% when compared individually. Creating trays of polymers to be used in tandem with high-throughput tensile testing methods immensely sped up the tensile testing process for polymers. Future direction for this research is to combine it with automated systems to create the trays autonomously and more quickly.

## THE EFFECT OF PRODUCTS CONTAINING ENDOCRINE DISRUPTORS, COLGATE TOTAL®, MICROBEADS, AND BPA, ON THE REGENERATIVE ABILITIES OF *DUGESIA IIGRINA*

Cynthia Leonard  
Spring Valley High School

Endocrine disruptors are found within several products which are prominent in everyday society, such as hard plastics, cosmetics, and personal care items such as toothpastes. The purpose of this research is to demonstrate how the endocrine disruptor containing products, BPA, Microbeads, and Colgate Total® affect the total regenerated lengths of *Dugesia Tigrina*, which could relate to the healing of damaged tissues within humans while being exposed to various products containing endocrine disruptors. It was hypothesized that the powdered form of BPA would hinder the Planarian Flatworms' total time of complete regeneration the most and that the endocrine disruptor within the Colgate Total® Toothpaste would have the least effect. A ppm solution was made for each endocrine disruptor containing product and were filled halfway into the assigned petri dishes, three dishes per group with a total of four groups, making twelve dishes total. Each planaria was cut halfway and the lengths were recorded after two weeks. The regenerated lengths were calculated and it was shown that there was a significant difference between means at  $F(3,77) = 3.74$ ,  $p < 0.05$ . A Post-hoc Tukey test determined that there were significant differences between the control and the BPA and the control and the Colgate Total®, which showed that both hypotheses were not supported. This meant that the BPA group did not have significantly the most hindering and that the Colgate Total® did not have significantly the least hindering overall.

## FECAL SOURCE TRACKING AT LITTLE CANE CREEK AND CANE CREEK

Ivey Li  
Governor's School for Science & Mathematics  
Mentor: Barbara Campbell, Clemson University

I used fecal source tracking methods to help the Friends of Lake Keowee Society (FOLKS) evaluate the sources of fecal contamination in Lake Keowee so they can take measures to reduce the levels of bacterial contamination. The presence of the bacteria was confirmed through Polymerase Chain Reaction (PCR); the samples were taken from Sites 10 and 11, Little Cane Creek and Cane Creek. We evaluated the presence of beaver, cow/deer, horse, human, and pig fecal contamination. The PCR results indicate fecal contamination from beavers and cows/deer at both sites. There were not significant levels of fecal contamination from horses, humans, or pigs at Little Cane Creek or Cane Creek.

## CAPABILITY OF COLLABORATIVE ROBOTS IN AN INDUSTRIAL PROCESS

Weston Light

Governor's School for Science & Mathematics

Mentor: Dan Askins, Integrated Systems Incorporated

The purpose of this project was to test the effectiveness of collaborative robots in an industrial process working with humans. We tested one of the very first dual armed collaborative robots called the YuMi made by ABB, a company that builds robots for industrialization. The YuMi is considered collaborative because it is designed to control and minimize collisions that could possibly cause harm to the robot and to the person working with it. The project was a case study funded by Kaydon Bearings and was intended to have the YuMi robot assemble bearings with the help of a person. The project began by video analyzing these processes in which the bearings were assembled by hand. The tasks that were categorized as dull, dangerous, or repetitive were designated as tasks for the robot. A key component to the project were the constant tests and trial runs that were required. Parts of the assembly were created in SolidWorks and constructed in the machine shop. We also had to add certain materials that were used in the initial process. Trial and error was used many times in order to create a solution that was acceptable for industrial use. This project will promote increased use of collaborative robots and prove that they are acceptable and even preferable in some industrial processes. As a result of this, people will not only become educated on robots and their applications, but they may work with robots instead of losing their jobs to one.

## SYNTHESIS OF WEAR RESISTANT POLYMERS WITH ENHANCED MECHANICAL PROPERTIES

Evan Livingston

Governor's School for Science & Mathematics

Mentor: Srikanth Pilla, Clemson University International Center for Automotive Research

Ceramics are used to manufacture several types of automotive components, such as gears, bearings and sliding components. Unfortunately, the problem of using these materials is that ceramic parts are quite heavy with densities about 5.0g/cc, which has a negative consequence on fuel efficiency. Our research has been focusing on using wear resistant polymers as a lighter alternative material for replacing ceramics in automotive vehicles. Wear resistant polymers share many resistant properties with ceramics under friction, temperature, pressure and abrasion conditions that make it well suited for the various environments inside a car. Using wear resistant polymers in place of ceramics, automotive companies can manufacture cars easier when they have to reach the Corporate Average Fuel Economy (CAFE) Standards for 2025 in the US. This will save money for drivers and the parents that pay for the gas being consumed in our cars every day. Using different ratios of wear resistant polymers and chemical fillers, we are investigating the best mechanical properties of these polymers. After the experiment we found that adding more of a chemical solution known as Erisys proved effective in increasing the overall polymer strength.

## THE EFFECT OF *NASTURTIIUM OFFICINALE* ON THE PREVENTION OF UNOXIDIZED SHEET STEEL CORROSION

Anne Lobitz

Spring Valley High School

The purpose of the research and experimentation presented was to determine if *Nasturtium officinale* can inhibit the corrosion of unoxidized steel. It was hypothesized that if all the components of a watercress plant are placed with 1M sulphuric acid then the metal placed with the plant will be protected from corrosion more than without the plant present. Distilled water and all parts of the watercress were placed in a glass test tube. The steel metal samples were weighed and added to the water and plant solution. After 24 hours, the samples were taken out of the solution to be weighed and observed under a stereoscope. The control group used the same method but did not add the watercress. The data were collected and statistically analyzed. The data showed that the control group that had no watercress had a larger difference between the mass taken before and the mass taken after than the experimental group with watercress. This suggests that the addition of watercress did inhibit the corrosion of the steel samples. A two sample t-test was performed to tell if the results were statistically significant. The test formula was  $t(37) = 43.60$  when  $p < 0.05$ . From this, it can be determined that the results are that the watercress helped inhibit corrosion of steel is significant. Watercress can be planted and possibly protect metal pipes in an environment where acid rain is a frequent phenomenon.

## THE EFFECT OF DIFFERENT MATERIALS ON BLOCKING CELL PHONE SIGNAL

Chris Lou

Heathwood Hall

The purpose of this experiment was to investigate the effects of various materials on their ability to block cell phone signal. Five different materials were compared, steel, tin, wood, glass, and plastic. The five materials were in the form of boxes, and they were used as cell phone signal blocker. Therefore, the results of this study could be used to determine which material would weaken the cell phone signal the most. The hypothesis of this experiment is that tin would have the most negative impact on cell phone signal strength. The results of this experiment supported the hypothesis. In conclusion, this experiment could benefit people by knowing where they should choose to go when they need stronger cell phone signal.

## ASSESSMENT OF TRAUMATIC BRAIN INJURY IN INFANTS USING DIFFUSIONAL KURTOSIS IMAGING

Emily Lowther

Governor's School for Science & Mathematics

Mentor: Donna Roberts, Medical University of South Carolina

When trying to identify the internal damage that is caused by abusive head trauma, it is difficult to show the injuries that are created deep in the brain using a traditional MRI. Traditional MRI creates images that show the difference between the white and grey matter in the brain, but it is difficult to distinguish between damaged and non-damaged white matter by simply looking at the scans. An alternate technique, such as diffusional kurtosis imaging (DKI), can be used to further analyze such injuries in white matter tracts. The main focus of this research is to use DKI to identify internal damage in cases of abusive head trauma in infants. The focus is on the internal capsule in the brain. These DK images were then processed using MATLAB and mricron to differentiate between extreme and less severe cases using parameters, such as kmean (mean kurtosis), dmean (mean diffusivity), and AWF (axonal water fraction). These parameters focus on the diffusion of water in the brain as well as along the axons that make up the white matter. Results indicate that three out of the four severe and fatal cases had higher kmean and AWF values than the less severe cases. However, one of the fatal cases did not have the same high values as others, but it followed the set curve made by the values of the patients with less severe head trauma. Further research is necessary in order to determine the efficacy of DKI in infant head trauma.

## THE GROWTH OF *MANDUCA SEXTA*

Sydney Lykins

Governor's School for Science & Mathematics

Mentor: Charles Beard, Clemson University

*Manduca sexta* is a nocturnal moth that is commonly grown under lab settings due to the ease of studying them. The moth's large size aids researchers in their ability to study the function of healing the proboscis for medical uses in the future. Usually, the moths are given only *Manduca* food (MDA), which is a man-made substance with nutrients that they need to grow, except carotenoids and cholesterol. These missing nutrients are what give the moths the ability to see and smell in order to find food, without them, it is hard for the moths to thrive in lab. This brings the question: how can *Manduca sexta* grow better under a laboratory setting? First, the larvae were fed a variety of foods with the missing nutrients (pumpkin puree, V8, and carrots). Each food was given alone and as a 50-50 mixture with the MDA. Through the weeks, the larvae's lengths were measured, and overall the pumpkin and MDA mixture, as well as the carrots and MDA mixture were the most successful in raising healthy larvae that turned into adults. Now the question of how to keep these new adults healthy arose. Deciding to test which height they prefer to collect their food from, three 7'5" nets were strung with Datura-like feeding devices that contained 35mL of 14% sugar water, each 17 inches apart. The conclusion was reached that the moths most frequently hovered and ate 51 inches from the ground.

## USING MOTION CAPTURE CAMERA TECHNOLOGY TO UNDERSTAND THE MECHANICS OF BUTTERFLY FLIGHT AT VARYING PRESSURES

David Madden

Governor's School for Science & Mathematics

Mentor: Brian Landrum, University of Alabama Huntsville

Butterflies were tested at various pressures to ascertain any useful data from the change of their flight mechanics. This research project is part of an ongoing series of research projects being conducted at the University of Alabama in Huntsville. The ultimate goal is to create a drone that flies the same way butterflies do, which would have many applications for homeland security. In this project specifically, data was recorded with a motion capture camera system that could track markers on the butterfly and upload it to a 3D computer environment. The collected data was then analyzed to see the trends in various factors. The most important of which were the lift coefficient and the Reynolds number. The lift coefficient is a unitless number used to show how much lift the butterfly is generating, while the Reynolds number essentially quantifies the turbulence of the flight. The results show that the lift coefficient increased at lower pressures and the Reynolds number decreased at lower pressures. Since both increase the efficiency of the butterfly's flight, future research projects investigating the change in a butterfly's flight mechanics, due to the pressure difference, would benefit the design of the drone.

## 3D BIOFABRICATION OF CANCER CELLS AND THE CHARACTERIZATION OF THE FISNAR I&J7100

Abson Madola

Governor's School for Science & Mathematics

Mentor: Jorge Rodríguez-Dévora, Clemson University

Up until now, scientists have used 2D models to test the effectiveness of cancer drugs. The issue with this method is that real, live tumors exist in three dimensions. In order to resolve this issue, a dispensing machine can be used to rapidly produce physiologically relevant cancer cells which can be aggregated to form tumors. The purpose of this experiment was to characterize the Fisnar I&J7100 dispensing machine so that it can be used to dispense 3D cell cultures and dispense drugs onto the cultures it creates. Water was used to test how pressure, dispense time, and viscosity affect the volume of liquid dispensed by the machine. Afterwards, 3T3 cells were dispensed and the relationship between cell count and dispense time was observed. The results showed that an increase in pressure and dispense time results in an increase in volume and that an

increase in viscosity results in a decrease in volume. In the future, these results can be used to dispense specific numbers of cells into specific volumes of medium. Overall, the Fisnar I&J1700 proves to be a suitable device for cell printing. It provides a way to rapidly dispense cancer cells/aggregates to be used for high-throughput drug screening.

#### CO<sub>2</sub> SEPARATION AND DRY METHANE REFORMING FOR SYNTHESIS SYNGAS BY A MECC MEMBRANE REACTOR

Vanessa Madrid

Governor's School for Science & Mathematics

Mentor: Kevin Huang, University of South Carolina Columbia

Currently, the most effective and cost-friendly source of energy for modern society is burning fossil fuels at power plants. However, this method produces greenhouse gases, such as carbon dioxide (CO<sub>2</sub>), which instigate a hazardous climate-change when emitted into the atmosphere. The kind of gas that is produced from combustion is called flue gas and is composed of N<sub>2</sub>, O<sub>2</sub>, and CO<sub>2</sub>. To prevent emission, the CO<sub>2</sub> must undergo either carbon capture and storage (CCS) or carbon capture and conversion (CCC) to be transformed into useful chemicals. However, the cost and energy penalty to implement current industrial technologies of CCS and CCC are so high that the overall plant efficiency and cost of electricity could be significantly impacted. This project focuses on developing a new class of cost effective and energy efficient mixed electron and carbonate-ion conductor (MECC) membranes. Each membrane is composed of a silver matrix and molten carbonate in order to separate the CO<sub>2</sub> from the simulated flue gas and then dry reform with CH<sub>4</sub> to produce syngas (H<sub>2</sub> and CO). The silver matrix is stabilized for high temperatures ( $\geq 650^{\circ}\text{C}$ ) by coating a nanoscaled layer of ZrO<sub>2</sub> using atomic layer deposition (ALD). This research focuses on investigating the dry methane reformation (DMR) performance and stability of the prepared MECC membrane reactor.

#### THE MOST EFFECTIVE WAY TO TEACH ENGLISH TERMINOLOGY

Skye Majka

Chapin High School

<p>Just minutes of studying vocabulary per day will expand someone's vocabulary and make them more effective learners. A problem that many high school students are faced with is that they are short on time and believe that learning vocabulary is too time consuming. The purpose of this research is to determine the most effective way for students at Chapin High School learn english terminology in a classroom setting. This study is significant because inform both teachers and students the best way to learn vocabulary which will result in less time students spent studying therefore an improvement in their grades. The aspects that explored in this investigation are flashcards, interactive matching game on quizlet, and reading the terms in context. The student's ability to assimilate 20 terms will be determined using a variegated test that will be given to students before then after they have studied terms in one of the three ways.</p>

#### OPTIMIZATION OF BIVECTOR SYSTEMS FOR EXPORT OF ISOPRENOIDS IN BIOFUEL APPLICATIONS

Samah Malik

Governor's School for Science & Mathematics

Mentor: Tzuen-Rong Tzeng, Clemson University

As the need for alternative energy sources has increased, many scientists have delved further into the production of biofuels, which are energy sources derived directly from living matter. In this research project, an economically efficient way to mass produce and harvest biofuels was explored. *Escherichia coli* DH10B transformed with plasmids encoding isoprenoids was used in the experiment for their production. The isoprenoid used in this part of the project was canthaxanthin. Using an Acridine Orange Assay, an attempt to validate the efflux pump activity encoded by plasmid EcoMsbA was made. *E. coli* DH10B with EcoMsbA and the control both did not show any fluorescence, indicating an issue. After testing the Assay, it was concluded that it was no longer good and does not cause fluorescence to be observed. Through the canthaxanthin protocol, the amount of canthaxanthin present could be calculated based on the absorbance at 460 nm.

#### EXAMINING THE EFFECTS OF TRAFFIC ON THE VOCALIZATION OF LITHOBATES CATESBEIANUS AND LITHOBATES CLAMITANS

Jillian Marlowe

Governor's School for Science & Mathematics

Mentor: John Quinn, Furman University

As urbanization increases, biodiversity often decreases. Urbanization affects the environment in many ways including increases in noise, habitat loss, and species extinction. The repercussions of extinction and habitat loss, such as loss of species diversity, disrupted food chains and invasive species, are obvious, but the effects of traffic noise are less apparent. The relationship between traffic noise and vocalization in animals has been studied broadly. However, little research about frogs exists. I studied the calls of Bullfrogs and Green frogs living both near and far from busy roads. Recordings were taken from eight sites and analyzed with Raven. The calls were isolated and analyzed using Raven. Neither the American Bullfrog or the Green Frog showed a change in their vocalizations. Understanding which species are able to adapt gives conservation biologists an idea of which species are more at risk of being affected by urbanization.

## EFFECTS OF CYSTEINE ON THE AGGREGATION AND DISSOLUTION OF SILVER NANOPARTICLES

Brandon Marrone

Governor's School for Science & Mathematics

Mentor: Mohammed Baalousha, University of South Carolina Columbia

This research investigated the aggregation rates of Silver Nanoparticles and how various levels of L-Cysteine and N-Acetyl-L-Cysteine could affect those rates. Silver Nanoparticles are industrially-made particles, used for their antimicrobial properties. When they make their way into the aquatic environment, they can have toxic effects on sea life, both large and small. We investigated the interactions between the Silver Nanoparticles and two different types of Cysteine, which is a naturally occurring biomolecule. We looked at what wavelength of light the Silver Nanoparticles were absorbing both before and after the interaction with the Cysteines as well as how much of that wavelength they were absorbing using the UV-Visual Spectrometer. We found that the Silver Nanoparticles alone absorbed light the most at 394 nm. When we observed the absorbance throughout the interaction, we found a quick drop in absorbance during the first ten second and then a slow decrease throughout the rest of the ten minutes we had the solution in the machine. We also measured the dissolution rates of the Silver Nanoparticles to see whether they would dissolve back into ions after they have already formed aggregates. Once the Silver Nanoparticles formed aggregates they were not as likely to dissolve as they were on their own. In the future it would be interesting to observe Silver Nanoparticle in the presence of biomolecules other than Cysteine.

## THE EFFECT OF ANTIBIOTICS ON THE PROTEIN CHANGES IN *E. COLI*

Ben Mathews

Heathwood Hall

The purpose of this research is to study the relationship between *E. coli* exposure to Penicillin and the protein changes taking place when complete antibiotic resistance is achieved, as well to test the concept of whether there is a relationship between protein changes and antibiotic resistance. The type of bacteria that was used was *E. coli*, and there were 4 different cultures that each built up resistance independent of the others. Antibiotic resistant bacteria are an emerging problem in developed and developing countries, so this research aims to provide insight into a possible link between antibiotic resistance and bacterial proteins. The *E. coli* strain used was OP50 and the *E. coli* was spread onto petri dish plates filled with RAPID'E.coli 2 Agar, and then a Penicillin disk was immediately placed onto each plate. After the 4th generation of repeating this process, the bacteria were collected and gathered for an SDS-PAGE protein electrophoresis. The hypothesis for this experiment was that if the *E. coli* bacteria are repeatedly exposed to the Penicillin antibiotic, then the surviving bacteria will exhibit resistance to Penicillin and a change in their protein structure. The experiment presented limited results that were not sufficient evidence to support my hypothesis or null hypothesis. In conclusion, the results suggest the methodology used is valid, but there was not a sufficient amount of data collected to prove or disprove the idea that protein changes in a bacteria can be linked to the exposure to Penicillin that these bacteria endured.

## NOX EMISSION REDUCTION IN POWER PLANTS

Aryana Mattmann

Governor's School for Science & Mathematics

Mentor: Bihter Padak, University of South Carolina Columbia

The emission of Nitrogen Oxides is extremely harmful to the environment. Power plants play a large role in the production of Nitrogen Oxides and as such their emission levels are highly regulated. Because of this, we were tasked with creating a model of the emissions created when burning syngas for the power plants to use. To do this we used a high pressure chamber to simulate the conditions of a power plant. We burned varying types of syngas in the pressure chamber. As the syngas burned, we collected the emissions and analyzed them to create our model. My job was to create the temperature controller and the pressure reader to use in the chamber, which was successful.

## ACCEPTABILITY OF AGEISM: THE ROLE OF AGEISM TYPE, RELATIONSHIP TYPE, AND AGE OF THE PERCEIVER

Morganne May

Governor's School for Science & Mathematics

Mentor: Michelle Horhota, Furman University

Ageism is prejudice towards a person based on their age, and can be either benevolent or hostile. This study was designed to determine if there is a significant difference between the perceived acceptability of benevolent and hostile ageist acts and whether that varies depending on the nature of the relationship between the person who is engaging in the ageist behavior and recipient. Young (18-34) and middle-aged (35-59) participants completed two surveys. First, participants rated the acceptability of 13 benevolent acts and 17 hostile acts. Next, participants rated how the acceptability of these acts varied for five different relationship types (younger family member, same-age family member, friend, familiar service worker, and unfamiliar service worker). Benevolent acts were rated as significantly more acceptable than hostile acts. There was no significant age difference in the perceived acceptability of benevolent ageist acts. However, young adults rated hostile acts as significantly more acceptable than middle-aged adults. We also found that the perceived acceptability of the ageist acts was positively correlated with the familiarity between the initiator and the recipient. This pattern held true across both types of ageism and both age groups. These results show that perceptions of ageism are multifaceted and depend on many factors such as the relationship type, ageism type, and age of the perceiver. Future work on this study will entail the collection of data

from older adults. This will help determine whether older adults are more or less sensitive to ageist behaviors than their younger counterparts.

#### CONVERTING A JAVA ASG TO A GENERAL ASG

Steven McDade

Governor's School for Science & Mathematics

Mentor: Brian Malloy, Clemson University

As the integration of technology into our society continues to increase dramatically, it has become necessary to have technologically literate people. A technologically literate person is one who can utilize their knowledge of algorithm and system design to help understand the world around them. To become technologically literate, people need to be able to understand how to write and understand basic code. To help people find and understand the inefficiencies in their code, a project developed a feedback system to measure quality of code via multiple metrics. In order to do this, Abstract Semantic graphs were used to get the user's code into a usable format. This project converts Java Abstract Semantic Graphs to General Abstract Semantic Graphs (ASG). An ASG is a graphical version of the source code and is unique for each language. Each ASG has its own system for tagging and graphing source code. This paper describes how to strip away the language specific elements and have a General ASG that can be analyzed using a variety of metrics.

#### E4 DOMAINS AND THEIR ANTI-FIBROTIC NATURE

Danielle McLaughlin

Governor's School for Science & Mathematics

Mentor: Carol Feghali-Bostwick, Medical University of South Carolina Columbia

Scleroderma is an autoimmune disease that has a high death rate due to fibrosis. Recently a peptide called E4 has been identified to lessen the effects and even treat fibrosis. However, this peptide is difficult and costly to synthesize. Therefore, research has been conducted to identify a smaller active domain of E4 to be used in treatments. This experiment was conducted over a three week period and began with the culturing of three cells lines: NL-98, NL-88, and NL-82. After, all of the cells lines were treated with TGF and/or peptide domains and harvested into cell lysates and supernatants. The lysates were then probed for GAPDH, Collagen 1A1, MMP, and Fibronectin, while the supernatants were probed for just Collagen 1A1, MMP, and Fibronectin. The data from the Western Blots were analyzed using densitometry. The final conclusion after looking at the resulting graphs is that peptide domain 91-96 is the active domain site, but further research will need to be conducted to confirm this conclusion.

#### THE MODELLING OF INDUSTRIAL CONTAMINANT SPILLAGE USING HYDRODYNAMICS IN CONJUNCTION WITH STEREOPHOTOGRAMMETRY

Thomas McLean

Spring Valley High School

Mentor: Kenny Mclean, CDS Corporation

Oil spills are a huge economic and ecological issue that many companies face every day. They cost millions of dollars to fix and cause devastating effects to the ocean's ecosystems. In the event of the Deepwater Horizon oil spill in 2010, around \$54 billion was lost in total when it was all said and done. The purpose of this experiment was to investigate the use of SPH modelling in conjunction with stereophotogrammetry in order model an industrial oil spill to predict which areas might be affected in a certain landscape. It is hypothesized that if a UAV is used to create a stereophotogrammetric model of a distinct landscape, this model can be integrated with SPH technology in order to accurately predict what areas of land would be affected in the event of an oil spill. First, pictures were taken of a landscape using an RTK Sensefly UAV. The point cloud data was then exported into a program called Global Mapper along with the GNS data and other aspects to create the stereophotogrammetric model. From this model, an industrial oil spill was modelled through the use of a raw digital elevation model (REM). Both an example of a saddle and a hill were tested. They showed the flow areas that were most likely to be affected and how much they would be saturated. This illustrated how the oil spread throughout the environment and the area that would be affected in a given amount of time. The model was able to successfully predict where the liquid would flow throughout the landscape and displayed this information. It showed the hypothetical pools of oil, and where they would accumulate the most during a spill. This would aid a response team reacting to the spill by giving them information on how far the oil had spread or by giving information on prevention of damage.

#### THE EFFECT OF SUCROSE AND ASPARTAME ON THE GROWTH OF *PLANARIA*

Rahithya Meda

Spring Valley High School

Obesity is a growing problem and has now reached epidemic proportions globally. Many people believe that an easy way to lose weight is by consuming diet foods and drinks. In reality, an ingredient, such as aspartame, does more harm to the body than good. The purpose of this experiment was to see how types of sugars can affect the regeneration of *Planaria*. It was hypothesized that if a concentration of 0.5 g/L of aspartame solution was fed to *Planaria*, then the regeneration growth of the *Planaria* would decrease. This experiment was conducted by placing *Planaria* into three different treatments: the control,

sucrose, and aspartame groups. Two concentrations of 0.5 g/L solutions were created using water and either sucrose or aspartame. The Planaria were fed boiled egg yolks combined with the solutions. The next day, they were dissected and allowed to regenerate for two weeks. The lengths and widths were measured every other day. The resulting mean areas were 0.0748 cm<sup>2</sup> for the control group, 0.0891 cm<sup>2</sup> for the sucrose group, and 0.02175 cm<sup>2</sup> for the aspartame group. The sucrose group had the greatest growth and area, followed by the control group, and then the aspartame group. The Kruskal-Wallis test results showed that the difference in the data were statistically insignificant because  $p > (H(2)=2.69, p = 0.1585)$ . The differences in the data were not significant, thus the hypothesis was not supported. However, the aspartame group did have a lower average area than the sucrose group. In conclusion, the effect of the different sugars had no significant differences on the growth of the *Planaria*.

#### EVALUATION OF SOLID MATERIAL MASS CASUALTY DECONTAMINATION

Hillary Melton  
Center for Advanced Technical Studies

Mass casualty decontamination is the process by which a hazardous agent is removed from victims thus reducing secondary exposure. The frequency and complexity of chemical, biological, radiological, nuclear, and high-yield explosive (CBRNE) incidents is increasing. Due to the difficulty of prevention and the scale of these attacks, a mass casualty decontamination process is necessary to remove the agent, protect responders, and prevent further exposure.

Researchers suggest that disrobing reduces 80 to 90 percent of the contaminate; however, there is no evidence-based data to quantify the effectiveness of decontamination. Efficiency of mass decontamination can be quantified by the percent change in body surface area contaminated. If a victim merely disrobes, then 80 to 90 percent of the contaminant will be removed while emergency and shelter decontamination scenarios will have an increased percentage of contaminant removal.

In preliminary testing, the mock contaminant, GloGerm powder, was dispersed onto test subjects using a pressurized PVC pipe system. Anterior and posterior photographs were taken of each test subject before and after decontamination. After analyzing the images in Photoshop a matched paired t-test was conducted. There was statistically significant evidence in order to reject the null hypothesis in favor of the alternative hypothesis stating that the mean difference in percentage of body contaminated between contaminated and decontaminated photographs is greater than zero. This conclusion suggests efficiency and reproducibility of disrobing decontamination. This method will be further evaluated during the final large scale experiment in April.

#### THE EFFECT OF IRON(III) OXIDE ON *DAPHNIA MAGNA* HEART RATE AND MORTALITY RATE

Shubhanjali Minhas  
Spring Valley High School

Due to the decrease in water infrastructure maintenance, many contaminants such as lead and rust find their ways into freshwater bodies. This increase of contaminants in bodies of freshwater could potentially have adverse effects on freshwater aquatic life. This experiment was designed in order to determine whether adverse effects of rust are present in *Daphnia magna*, a vital part of the freshwater ecosystem. *Daphnia magna* heart rate as well as mortality rate were tracked throughout experimentation, with the hypothesis that an increase in heart rate and mortality rate would occur in *Daphnia* exposed to rust. Ninety *Daphnia* were used in experimentation, with 29 *Daphnia* being exposed to the control treatment, 32 *Daphnia* being exposed to the 5 mg/L iron (III) oxide treatment, and 29 *Daphnia* being exposed to the 5.5 mg/L iron (III) oxide treatment. All three treatments were kept in a constant environment, and *Daphnia* food was administered every 2 to 3 days. Heart rate data was analyzed with the use of an ANOVA test at alpha equal to 0.05. It was found that heart rate averages between the three treatments did not significantly differ, with  $p > \alpha$  ( $F(2, 27) = 0.64, 0.5336$ ). It was also found that no significant impairment of lifespan occurred. A presence of iron (III) oxide was observed within *Daphnia* and on the exterior of deceased *Daphnia*, leading to the conclusion that ingestion of this substance did occur.

#### THE EFFECT OF TEMPERATURE, PRESSURE, AND HUMIDITY ON EMF SIGNALS

Clay Mitchell  
Heathwood Hall

The purpose of the experiment was to find a pattern in EMF reading related to temperature, pressure, and humidity. The results of this study suggest that that EMF readings varied because of pressure, temperature, and humidity. The hypothesis (H1) stated that if the temperature is above 15° C and the pressure is greater than 760 mmHg, then the EMF reading should be stronger. The results supported H1; the EMF at all locations was related to temperatures. The EMF was related to pressure at the library and humidity at the middle school. The hypothesis (H2) stated that if the temperature is above 15° C the pressure is greater than 760 mmHg and humidity is above 24%, then the EMF reading should be weaker. The results of this study also supported H2; EMF readings were impacted by by humidity at both the library and the center of campus, and pressure at the middle school. The null hypothesis (H0) stated that if the temperature is above 15° C the pressure is greater than 760 mmHg and humidity is above 24%, then there would be no change in the EMF readings. H0 at the center of campus was supported by pressure.

## SPLITTABLE COVERINGS OF THE INTEGERS

Sydney Miyasaki

Governor's School for Science & Mathematics

Mentor: Gregory Clark, University of South Carolina Columbia

Let a tile be defined as a non-empty subset of the integers. The concept of decomposable coverings as discussed by J. Pach and G. Toth can be extended to these integer tiles. In this context, a decomposable covering is defined as any covering of  $\mathbb{Z}$  that can be partitioned into two distinct coverings of  $\mathbb{Z}$ . Furthermore, we show that any finite integer tile can be used to construct a decomposable covering and provide bounds for the densities of such coverings. These results are expanded upon in the case of three-element integer tiles.

## CHARACTERIZING THE MECHANICAL PROPERTIES OF JSC MARS-1A MARTIAN SOIL SIMULANTS

Anjali Mohan and Ian Wilde

Governor's School for Science & Mathematics

Mentor: Qiushi Chen, Clemson University

The lunar landing was an enormous step in humanity's exploration of space. At last we're nearly ready to take the next step—a human landing on a nearby planet. Scientists at NASA (National Aeronautics and Space Administration) predict that sometime in the 2030's, humans will land on Mars. In order to reach this goal NASA has created a road map of technological goals that must be accomplished prior to launch. This research project complements a recent SC NASA Space Consortium funded project to study the feasibility of using simulated in-situ Martian soils to create functional building blocks. The objectives of this project are to characterize the mechanical properties of JSC-1A Martian soil simulant, in particular, the grain size distribution and shear strength of the simulant, through a series of soil mechanics experiments. Secondly, to compile, analyze and prepare experimental data for calibrating numerical models. In order to observe the grain size distribution, sieve analyses and hydrometer analyses were performed on the Martian simulant. To test the shear strength and calculate the friction angle of the simulant, shear tests were run. The results from these tests can be used to help determine whether the Martian regolith can be used to construct building blocks on Mars.

## DIGITAL VILLAGES DISCOVERABLE: CONCEPTUALIZING, DESIGNING, AND IMPLEMENTING THE USER-INTERFACE OF A CROWD-SOURCED, MEDIA-UPLOAD, IOS APPLICATION

Hailey Mollica

Governor's School for Science & Mathematics

Mentor: Simon Scherr, Fraunhofer Institute for Experimental Software Engineering

A continuous migration trend, especially by the younger generation, to urban areas because of ease access to services and resources is becoming an increasing problem for the rural areas of Germany in terms of both attractiveness and infrastructural demand. The motivation of the "Digital Villages: Discoverable" project was to provide a supplemental, crowd-sourced application to an already existing project, "Digital Villages" aims to reverse the aforementioned trend and provide assistance for those affected by ways of "digitization." In an effort to promote inter-community relationships and historical importance of some of these rural areas, the ideas of "Digital Villages: Discoverable" was created. In the span of five and a half weeks, a prototype of an iOS user-interface for an app was conceptualized, designed, and the initial steps of programming were implemented in XCode. The user-interface prototype provided the basic functionality of taking/selecting, resizing, and uploading photos through a network transfer connected to the back-end and a complete view-controller framework storyboard. Future work includes completing the interface and fully connecting it to the back-end services. Following this, necessary testing of the finished app with a real user-base to identify and improve any run-time problems and collect improvement feedback should be executed.

## THE EFFECT OF THE T4 BACTERIOPHAGE, SUBLETHAL CONCENTRATIONS OF CIPROFLOXACIN AND METRONIDAZOLE, AND COMBINED PHAGE-ANTIBIOTIC USE ON *ESCHERICHIA COLI* B COLONY DENSITY

Austen Money

Spring Valley High School

Crohn's disease is a type of chronic inflammatory bowel disease. The exact cause of the disease is unknown, but recent research suggests a correlation to high levels of pathogenic strains of *E. coli* in the gastrointestinal tract. These strains are antibiotic-resistant, which creates a need for alternative antibacterial therapies such as phage therapy. Phage therapy is a technique that uses viruses to infect and kill bacteria. The purpose of this experiment was to test the effectiveness of phage therapy in combination with sublethal levels of antibiotics, which has been shown in previous research to improve the antibacterial properties of the phage, against a similar strain of *E. coli*. The antibiotics used in combination with the phage were metronidazole and ciprofloxacin, the two most effective drugs used to treat patients with Crohn's disease. It was hypothesized that a combination of ciprofloxacin and a dilution of a phage would result in fewer *E. coli* colonies in the bacterial lawn of growth. During experimentation, an agar plate was inoculated with a strain of *E. coli* B, and using a double-layer plaque assay, the bacteriophage and a low concentration of either metronidazole or ciprofloxacin were also added to the plate. This was repeated for the six groups, with a control, a group treated with only the phage, and one group for each antibiotic treatment not in combination with the phage. It was found that adding metronidazole to the phage significantly

improved the antibacterial properties of both treatments, and although the ciprofloxacin/bacteriophage treatment was the most effective, there was not a significant difference between this treatment and the ciprofloxacin treatment.

#### SINGLE-STRANDED DNA INVESTIGATION USING FLUORESCENCE ANALYSIS AND COMPUTER SIMULATION

Yohan Moon

Governor's School for Science & Mathematics

Mentor: Soo Yong Kim, Korea Advanced Institute of Science and Technology

G-Quadruplexes are structures found within telomeres, which are found at the ends of chromo-somes. They are made of single-stranded DNA (ssDNA), and have recently been found to have many uses in the prevention of cancer, particularly in the area of drug delivery. The typical strand found in the telomere has a nucleotide sequence of TTAGGG. We tested to see if a strand with the same base pairs but in a different order, TGTGAG or TAG, could form G-Quadruplexes. This would tell us whether or not the guanines have to be adjacent to each other for the stacking interaction to take place. We found that the persistence length of the telomeric strand was higher than TAG through Fluorescence Correlation Spectroscopy (FCS). This meant that the telomeric strand was more rigid than TAG within the solution. This can be attributed to the presence of G-Quadruplexes, meaning they did not form in the TAG strands.

#### G418 TREATMENT FOR THE SUPPRESSION OF A NONSENSE MUTATION IN THE X-LINKED INTELLECTUAL DISABILITY GENE CUL4B

Claire Moore

Governor's School for Science & Mathematics

Mentor: Anand Srivastava, Greenwood Genetic Center

Intellectual disabilities affect approximately 1-3% of the global population, and nonsense mutations in various regions of the X chromosome are primary causes of these diseases. Nonsense mutations are changes to DNA that create premature stop codons, which code for truncated proteins that are often non-functional. Studies have shown that people with a nonsense mutation in the CUL4B gene, which normally encodes a cullin protein and promotes the ubiquitination of several histones, have a syndromic intellectual disability. Some of the symptoms associated with the mutant phenotype are enlarged head, abnormal gait, and short stature. One proposed treatment approach for genetic diseases like syndromic intellectual disability is to suppress the nonsense mutation causing the disease by administering a low molecular weight drug. Previous research has shown that aminoglycosides bind to the ribosome and allow protein elongation to continue even in the presence of a premature stop codon. Despite this discovery, aminoglycosides have not been widely-tested to combat intellectual disability. We examined the ability of the aminoglycoside, G418, to treat kidney cells that contained a nonsense mutation in CUL4B. Western Blots showed that G418 successfully produced a read-through of CUL4B wild-type protein from a mutant CUL4B gene, and immunofluorescence determined that the nonsense mutation did not affect the normal localization of CUL4B. Further research can examine the ability of G418 to produce read-through from other nonsense mutations. Additionally, future research can investigate how to minimize the side effects from aminoglycoside toxicity.

#### INCREASING AFRICAN AMERICAN TOURISM IN SOUTH CAROLINA

Daniel Morris

Governor's School for Science & Mathematics

Mentor: Simon Hudson, University of South Carolina Columbia

This study was conducted to identify key characteristics of the African American population that may provide insight into that population's travel habits and motivations. South Carolina's strengths and weaknesses in attracting this tourism segment are evaluated. The results of this study will be used to craft marketing strategies that target African American tourists so that they are more likely to consider South Carolina for their next tourist destination.

#### MINIMAL INHIBITORY CONCENTRATION OF CHITOSAN

Nitya Muppala

Governor's School for Science & Mathematics

Mentor: Tzuen-Rong Tzeng, Clemson University

Implants have found widespread use in medicine, but they are not a perfect solution due to certain drawbacks. For example, there is a high chance that biofilms will grow on the surface of the implant, which cause infection and usually call for the replacement of the implant. The objective of this research was to find a way to inhibit the growth of bacteria *Staphylococcus aureus* strain Seattle 1945 using chitosan. Chitosan, a polysaccharide derived from chitin, is most commonly found on the exoskeletons of shellfish, especially shrimp, and has many uses including inhibiting bacteria growth. Layering a certain amount of chitosan on the implants would inhibit the growth of bacteria, allowing it to stay in the patient longer with no need for a replacement. This certain amount of chitosan needed is called the minimal inhibitory concentration (MIC). To find the MIC, chitosan was dissolved in 0.5M acetic acid. After serial dilutions, the solutions were pipetted into a 96-well plate and left in an incubator overnight and then inspected the next morning. The first well was clear indicating the MIC while the other four wells were turbid. A spectrophotometer was used to help measure the concentration and MIC of chitosan in the well.

## THE EFFECT OF PHOTO FILTERS ON THE EMOTIONAL RESONANCE OF TEENAGERS

Danielle Murrin  
Spring Valley High School

Photo filters are a type of software routine in which the appearance of an image is altered due to an adjustment in shade and color of the pixels. Photo filters have been known to change one's emotional resonance by affecting the person's own individual emotion and/or feeling. The purpose of this experiment was to see if there was a correlation between dark vs light filters and the emotions associated with them. In this experiment, photos with different filters were viewed by participants in order to observe any changes in their emotion after viewing the different filters. It was predicted that the dark filters (mono, tonal, and noir) would correspond more with the negative emotions while the light filters (chrome, process, and instant) would correspond more with the positive emotions. The negative and positive emotions were determined by using the eight primary emotions from Robert Plutchik's theory and categorizing them into negative or positive. The negative emotions were anger, fear, sadness, and disgust while the positive emotions were surprise, anticipation, trust, and joy. Experimentation was accomplished by giving 30 participants 15 seconds to view each of the following: the photo blank, control (no filter), and each of the photos with the different filters. Surveys were used prior to testing and throughout testing in order to record the participant's emotion. The hypothesis that the dark filters would correlate with the negative emotions and that the light filters would correlate to the positive emotions was supported. At  $\alpha=0.05$ , there was a difference in the emotions that corresponded to dark vs light filters,  $F(7,232)=17.55$ ,  $p<0.0001$ . In conclusion, dark filters corresponds to negative emotions while light filters correspond to positive emotions.

## THE EFFECT OF CLINOPTILOLITE VS. DICYANDIAMIDE ON NITRATE LEACHING 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 a 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 clinoptilolite minerals vs dicyandiamide were observed in this experiment. It was hypothesized that 5 grams clinoptilolites will reduce the amount of nitrate leaching from silt loam soil greater than the 5 grams of dicyandiamide. A one-way ANOVA showed that the differences between the control ( $n = 30$ ,  $M = 9.000$ ,  $SD = 2.034$ ), the clinoptilolite soil mixtures ( $n = 30$ ,  $M = 4.172$ ,  $SD = 2.575$ ), and the dicyandiamide soil mixtures ( $n = 30$ ,  $M = 7.633$ ,  $SD = 2.846$ ) were statistically significant,  $F(5,174) = 50.07$ ,  $p < 0.001 < \alpha = 0.05$ . A post hoc Tukey test was performed with the data at an  $\alpha = 0.05$  on the nitrate concentrations of different soil mixtures to decide where the mean differences are between the groups. 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 clinoptilolite and dicyandiamide soil mixtures. There was also a significant difference between the before after of the clinoptilolite soil mixtures, the before and after data of the dicyandiamide soil mixtures, and the after data of the clinoptilolite and dicyandiamide soil mixtures. These results show that the clinoptilolite decreased the nitrate leached from silt loam soil more effectively than the dicyandiamide. In conclusion, the hypothesis was supported and clinoptilolite could potentially be used to reduce the amount of nitrate leached from soil.

## THE EFFECT OF CALORIC LABELING ON CONSUMERS CALORIE INTAKE

Kate Nassab  
Heathwood Hall

While the addition of calorie count on restaurant menus may seem insignificant, previous studies have shown that the addition of calorie count can lead consumers to choosing a healthier meal. The purpose of this experiment was to investigate the impact caloric labeling on a menu can have on a consumer's choices. The independent variable was the menu type, either labeled or not labeled. The dependent variable was the calorie intake. For this study the hypothesis was, if a menu includes calorie count, then the subjects viewing the menu will consume less calories than subjects ordering off the menu without calorie count. The null hypothesis was, if a menu includes calorie count, then the subject viewing the menu will consume the same number of calories as subjects ordering off the menu without calorie count. Out of the forty participants, the first 20 were asked to choose one entree and one drink off of a menu that had calorie labeling, and the other 20 participants were asked to choose one entree and one drink off the not labeled menu. Next, the calories ordered from participants off of the two menus were compared and a T-Test was conducted. The results suggest that on average, participants who had a menu with calorie count ordered fewer calories than participants ordering off of the not labeled menu. The results were proven to be statistically significant and the null hypothesis was rejected.

## MEASUREMENT OF THE FLORY HUGGINS INTERACTION PARAMETER OF PHA-PS AND PHA-PLA

Lam Nguyen  
Governor's School for Science & Mathematics  
Mentor: Morgan Stefik, University of South Carolina Columbia

The Flory-Huggins Interaction Parameter is the repulsive force between two diblock copolymers; diblock copolymers being unique with the ability to transform into many different known morphologies and the ability to retain properties of the two different copolymer chains consisting the diblock. In this experiment, the novel polymers, PHA-PLA [HL] and PHA-PS [HS],

were studied for their previously not characterized parameters. After synthesizing the polymers accordingly, the polymers are then characterized through gel permeation chromatography (GPC) and nuclear magnetic resonance spectroscopy (NMR) verifying their successful synthesis. The polymers are then prepared in slides to be studied through small angle x-ray scattering (SAXS). To study a polymer's Flory-Huggins Interaction, the polymer must be in its molten form, or the disordered morphology. As temperature rises, the Flory-Huggins Interaction Parameter decreases and eventually results in the disordered morphology, a mixed pool of the copolymers. After attempting to disorder the polymer using Linkam, the polymers were then observed to be ordered. The polymers were found to be robust and maintain a low, however not specified, Flory-Huggins Interaction Parameter through comparison to other similar polymers.

#### THE EFFECT OF DIFFERENT LEVELS OF CAFFEINE ON THE GROWTH OF WISCONSIN FAST PLANTS

Hailey Nicks  
Heathwood Hall

The purpose of this experiment was to study the effects of various concentrations of caffeine on the growth of Wisconsin Fast Plants. Five different caffeinated liquids were compared in the study, coffee, green tea, chai black tea, vanilla spice chai tea, and 5 Hour Energy. The effects of the five liquids were compared to those of the control group. The plants were set up to absorb a mixture of water and eight ounces of the respective caffeinated liquid, or in the case of the 5 Hour Energy, two ounces, and were left to grow for four weeks. The hypothesis was that the 5 Hour Energy will enhance the growth of the Wisconsin Fast Plants by the largest amount, due to the drink containing the highest levels of caffeine when compared to the other substances in use in the experiment. The results of the experiment supported neither the hypothesis nor the null hypothesis, as the coffee group showed the greatest growth, on average, out of all of the plants. 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 RELATIONSHIP BETWEEN GENERAL ANXIETY AND LANGUAGE DYSFLUENCIES IN MOTHERS WITH THE FMR1 PREMUTATION

Haley Nolan  
Governor's School for Science & Mathematics  
Mentor: Jessica Klusek, University of South Carolina Columbia

The FMR1 premutation is an X-linked genetic mutation that causes an increase in CGG repeats on the FMR1 gene. This mutation affects one in every 151 females. The mutation can cause delays in cognitive ability and these delays can, in turn, affect the ability to communicate. It was hypothesized that there would be a statistically significant positive correlation between language dysfluencies and anxiety levels in women with the FMR1 premutation. To collect the language dysfluencies, each participant was asked to participate in a five-minute speech sample (FMSS) in which she spoke about her child for five minutes without any interruptions. After the FMSS was recorded, the videos were transcribed and reviewed for revisions, repetitions, pauses, abandoned utterances and filler words. These factors were considered the language dysfluencies. Each participant was also asked to take the Becks Anxiety Inventory Questionnaire. This questionnaire provided the anxiety scores that were run against the language dysfluencies to determine if there was a correlation between the two. It was determined that there was no relationship between anxiety scores and language dysfluencies in mothers with the FMR1 premutation. However, there was a statistically significant positive correlation in mothers without the premutation. In the future, other possible reasons behind the language dysfluencies will be investigated in these participants with the hope of obtaining a better understanding of how outside factors affect mothers with the FMR1 premutation.

#### THE EFFECT OF COPPER(II) SULFATE PENTAHYDRATE ON THE PRODUCTION OF THE ETHYLENE HORMONE ON *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 ethylene, represented by parts per million (ppm), produced by *Cucurbita pepo* plants. If the copper (II) sulfate pentahydrate were to positively affect the amount of ethylene, the plants would have adequate color and texture. It was hypothesized that the copper (II) sulfate pentahydrate would cause the zucchini plant to produce less ethylene, thus causing poor physical characteristics of the plants, such as poor color. 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 matured. The experimental group was given the same amount of sunlight but 26% concentrated copper (II) sulfate pentahydrate everyday. Both groups had the same amount and type of soil. After the control group plants matured, the ethylene was measured using an electrochemical ethylene sensor, also referred as an ethylene meter, obtained from Amazon.com. This measures the amount of ethylene produced by each plant. Each plant was separated from the rest. Graph 1, a bar graph, shows how much higher the amount of ethylene ppm was for the control group rather than the experimental group. Graph 2, a box plot, also shows the difference between the control group and experimental group mean value and the maximum and minimum value. The unpooled 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 ethylene ppm than the experimental group ( $M=0.12$ ,  $SD=0.06$ ),  $t(29) = 23.90$ ,  $p < 0.0001$ .

## EFFECT OF ETHANOL ON THE MAGNETIC PROPERTIES OF GOLD AND COBALT BILAYER FILM

Juliet O'Riordan

Governor's School for Science & Mathematics

Mentor: Scott Crittenden, University of South Carolina Columbia

This research focuses on how the surface application of ethanol to very thin gold/cobalt bilayer films affects the magnetic hardness of the material. The planar Hall voltage resulting from an applied voltage and magnetic field was measured and plotted through 600 oscillations. Two peaks are repeated through every oscillations and can describe magnetic properties of the material. An increase in the distance signifies it has become magnetically harder making it more difficult to switch the dipoles back and forth. It was found that ethanol shrinks the distance between the peaks making it easier to switch the dipoles which is useful to consider when making computer hard drive read write heads.

## SYNTHESIS AND INVESTIGATION OF THE NAPHTHALENE BIS-UREA MACROCYCLE

Jack Orlandi

Governor's School for Science & Mathematics

Mentor: Linda Shimizu, University of South Carolina Columbia

Bis-Urea macrocycles can be very useful when running reactions to yield certain products. As the functionality of these macrocycles can change along with the C-shaped spacer that is used to create the macrocycle, it is desirable to investigate these different possible spacers to determine if the macrocycle they make up will be of any use. The spacer chosen to be investigated in this research is naphthalene, due to its interesting properties and its availability. The naphthalene macrocycle was synthesized, and various tests and calculations were performed on it to test how it would form, how its absorption spectrum would change, and how large its channel would be. These tests were run successfully using the protected NMC that was formed, providing insight into several of NMC's properties. The tests show that a normal, columnar assembly would be expected from NMC, with a minimum energy value of -1374.705 Hartree. It is also seen that the absorption spectra of protected NMC and naphthalene have peaks at similar locations, 225 and 275 nm. Lastly, the tests show that the channel of NMC has a width of 0.5101 nm and a length of 0.3630 nm when measured from the centers of the atoms, meaning that there is not sufficient room for any gas to be loaded into the interior of the NMC's channel. The research conducted helped to understand some properties of the protected NMC and make assumptions of how NMC would act once it was formed.

## THE EFFECT OF PAST TRAUMA ON THE BODY'S RESPONSES TO STRESS

Nancy Ou

Governor's School for Science & Mathematics

Mentor: Keri Weed, University of South Carolina Aiken

Stress signals go through many systems within the body including the autonomic nervous system, the central nervous system, the sympathetic nervous system, and the parasympathetic nervous system. These systems work to elicit and quell responses from the brain and body in the occurrence of stress. Stress has long been found to be the cause of common cardiovascular diseases. However, the manner of response due to stress varies among individuals because each individual has different characteristics such as race, age, gender, and even past trauma. As a result, there has been no effective way to identify groups of individuals who are at a higher risk for cardiovascular disease. This study specifically investigated how past trauma will either inoculate or sensitize the victim to stress by exposing two groups of participants – No Trauma and Trauma groups – to physical and psychological stressor tasks. Their responses were recorded and compared in terms of electrodermal activity (EDA), heart rate, and their perceptions of anxiety. Subjects within the Trauma group showed higher responses in every task with few exceptions. These results supported the hypothesis that victims of past trauma will be sensitized to stress. The small sample size of seven participants accounted for almost all discrepancies discovered during the study. Due to the nature of the research, the parasympathetic nervous system was not extensively studied; further research into this system could potentially discover ways to lower accumulated stress within the body and decrease the risk for cardiovascular disease.

## ANALYSIS OF THE HYPERACTIVITY OF A MUTANT MPMING TRANSPOSABLE ELEMENT

Gabriel Paradise

Governor's School for Science & Mathematics

Mentor: Nathan Hancock, University of South Carolina Aiken

mmPing20 is a sequence of DNA called a transposon. These transposons are capable of excising from the genome and moving to another region given the appropriate conditions, including the presence of the proteins required for excision. mmPing20 is a hyperactive transposon, as it contains 7 point mutations that somehow cause hyperactivity in the element. By testing different mutant varieties that had mutations similar to those found in mmPing20, comparisons can be drawn between the transposition rates of the mutants and mmPing20 to see if any individual or combination of mutations are responsible for the hyperactivity of mmPing20. The transposition rate of the mutants was measured using yeast as a chassis. The mutant DNA was transformed into the ADE2 gene of the yeast. This gene produces a necessary protein for yeast to grow, adenine. While the transposon is in the gene and the yeast is on a plate with no adenine present, the protein will not be produced and yeast will not grow, and whenever it transposes, a colony will form. Counting these colonies returns the number of transpositions that occur. After running the tests, it was determined that only a full combination of the mutation would result in the hyperactivity of the transposon. However, the results are still inconclusive as of yet because the mmPing20 control did not

function during the duration of the experiment. Therefore, the reference used for the experiment was outdated and could be inaccurate.

#### A COMPARISON OF FORMATIVE AND SUMMATIVE ASSESSMENTS ON THE LEARNING RETENTION OF ADOLESCENTS

Sarayu Parise  
Spring Valley High School

Assessments are what allow educators to evaluate if the technique in which they taught the topic was effective amongst a sample, and it allows students to adjust their learning process as well. The purpose of the study was to improve upon previous research on the topic of educational pedagogy. Specifically, the study focused on assessments and their impact on the learning retention of students. The two types of assessments were given to see which was more beneficial, or in other words, which would allow them to keep the information in their memory more effectively. If students were taught the same topic but were given a different combination of assessments, the students that had an increased and consistent amount of formative assessments initially would show more retention of the content rather than the students who took just the summative assessment, based on the percentage increase of the scores. Two groups were both taught the subject with no difference in the original teaching style, information, or the teacher, but one group had a consistent exposure to formative assessments as they were taught the topic, while the other only took the summative at the end with less in class feedback. After two weeks, the participants were retested to determine the long term retention. The two groups were compared based on the percentage increase or decrease of the scores. The hypothesis was not supported. Results indicated that the summative only sample group had a more positive and significant percent increase than the other. An unpaired t-test indicated that the results were statistically significant and different because the p-value of 0.0453 was less than the alpha value of 0.05. It was concluded that the summative assessments may have provided as better motivator for the scores because of previous grades, however the formative enriched group had less variance because they did the assessments as a class.

#### IMPACT OF ALCOHOL CONSUMPTION ON BODY MASS INDEX

Daniel Patino  
Governor's School for Science & Mathematics  
Mentor: Bernadette Marriott, Medical University of South Carolina

Numerous studies have been done on how alcohol consumption affects weight and body mass index. It is a controversial topic in today's society because people want to stay away from foods and beverages that make them unfit. Alcohol companies make the population believe that alcohol has a good effect on them. They do this by producing commercials of fit individuals drinking a cold beer or wine. The commercials turn down any ideas that alcohol makes you bigger. Researchers all over the world have tried to find a set correlation between alcohol consumption and body mass index, but there is no set answer. Some say you lose weight, while the majority say it makes you gain weight. The purpose of this study is to look for our own answer to this controversy. Working alongside the BRAVO study, which worked on how Omega-3's affected depressed individuals, we tried to find a correlation between the type of alcoholic beverage and the average body mass index. The sample was divided into people who drank daily, weekly, and monthly. There was also a category for people who never drank. Once the data was compiled, it could be seen that there was no significant relationship between the type of alcoholic beverage and body mass index. It was concluded that a future study should be done with better methods, consisting of more participants and more controls. It was hard to control in this type of study because of all the dietary factors that come into play.

#### MODELLING HUMAN ACTIVITY THROUGH STRUCTURAL VIBRATIONS WITH ALTERNATE COMPUTATIONAL DEVICES TO INCREASE COST EFFICIENCY

Elaine Patterson  
Spring Valley High School  
Mentor: Juan Caicedo, University of South Carolina

Every event that occurs has a reaction, whether it be a pebble causing ripples in a pond or a bullet distressing a wall. Within a structure, these vibrations caused by a specific event in a medium can be measured with an accelerometer, and just as the vibrations caused by a bullet observably differ from those caused by a pebble, vibrations caused by walking vary from those caused by falling, running or jumping. To the eye, these differences are slight to severe, but when that signal is dissected, it is identifiably unique by its cause and location with extensive applications from home security to behavior analysis for medical care (including fall detection) to commercial analysis of foot traffic. The focus of this study was to investigate how this signal is collected -- specifically, if a cheaper (and independent) computer could replace a setup that currently costs thousands. The Raspberry Pi was used with an ADXL345 accelerometer as this alternate system. The study included notes of development of the hardware and software as well as analysis of the developed system by comparison to the accepted system. The new system is enabled to continuously read the accelerometer's z axis output value, maintaining a buffer and saving significant signals. These hypothesized capabilities were confirmed by collecting vibration data from the same impact and comparing how each system recorded the event.

THE EFFECT OF NONASSOCIATIVE LEARNING COGNITIVE PROCESSING ON ALZHEIMER'S DISEASE SEVERITY  
IN *CAENORHABDITIS ELEGANS*

Gillian Patton  
Spring Valley High School

Nonassociative learning is a type of cognitive processing in which behavior towards a stimulus changes without any apparent associated stimulus. It provides a possible method of treatment for preventing the buildup of amyloid- $\beta$  (A $\beta$ ), which causes the nervous system deficits that are characteristic of Alzheimer's disease (AD). Developing a new method of treatment for AD would allow patients with AD to improve their condition and would provide preventive measures for individuals with family histories of AD. It was hypothesized that if chemosensory habituation was applied to *Caenorhabditis elegans*, then the amount of amyloid- $\beta$  would be lessened. The test groups were mechanosensory habituation, chemosensory habituation, habituation to a novel environment, and three controls. The mechanosensory habituation group experienced touch cell stimulation, the chemosensory habituation group experienced repeated exposure to an attractive odorant, and the habituation to a novel environment group was introduced to a different petri plate. The control group was exposed to no habituation. After each test day, the presence of amyloid- $\beta$  in the worms was quantified by counting how many and which of the worms had succumbed to paralysis. The worms in the test groups took longer to become paralyzed and less worms became paralyzed than in the control group. The equation  $F(4,147)=16.9544$ ,  $p<0.00001$  was also used to run the one-way analysis of variance (ANOVA) test. There was a significant difference between the test groups. It was found using a Scheffé test that the difference existed between the control group and the test groups, suggesting that the use of nonassociative learning had a positive effect in mitigating the buildup of A $\beta$  in *C. elegans*.

THE EFFECT OF BISPHENOL-A SUBSTITUTES ON THE HEART RATE OF *DAPHNIA MAGNA*

Matthew Payne  
Spring Valley High School

For over a decade, people have been aware of the negative effects of Bisphenol-A. However, the knowledge surrounding the substances now replacing BPA is much more limited. These BPA substitutes include Bisphenol-F and Bisphenol-S, known also as BPF and BPS respectively. Liou et. al (2012) shows that the urinary concentrations of Bisphenol-S are rising in eight countries studied, including the United States. This has the potential to become an even bigger problem. Without knowing what these BPA substitutes can do before using them, there is no way to see the danger that could be associated with them. The purpose of this study is to reveal the potential consequences of using these chemical compounds widespread. These may have impacts that have yet to be discovered, both for humans and the environment. The hypothesis is as follows: The highest concentrations of BPS and BPF will cause the greatest fluctuation of heart rates from the mean. This hypothesis was tested by using *Daphnia magna* and adding the three substances mentioned above to their pond water in various concentrations. After that, to determine the effects that those substances actually had, the data was analyzed. The analysis showed that the higher concentration (2.49 ng/ml), was significantly different that control group for both substances. The group with BPS had a higher mean than the BPF group but it was not significantly higher. Therefore, it is apparent that Bisphenol-A substitutes are not safe either. In fact, BPS and BPF held significant differences from the control, while the last study of BPA alone yielded no significant difference. It shows that BPA substitutes are more dangerous and have more harmful long term effects than BPA itself.

COMPARISON OF AUTOMATIC VERSUS HAND CODING TECHNIQUES IN EYE TRACKING SOFTWARE

Dennis Perea  
Governor's School for Science & Mathematics  
Mentor: R. Andrew Hurley, Clemson University

In the fast paced world we live in today, researchers look for techniques that can increase productivity while decreasing research time. In the growing field of wearable eye tracking, studies traditionally take significant amounts of time, especially coding during data analysis. The time-consuming nature of hand coding can cause researchers to lessen the complexity of the study or cut the number of participants in order to meet deadlines. Tobii Pro Analyzer Software has offered a solution to this problem by introducing automatic coding, which can save a considerable amount of time and money. However, this software is in its infant stages and is still in the process of being refined. In this study, the data from 15 participants shopping for chocolate and cereal was analyzed using hand coding and automatic coding. Significance tests were performed to determine statistical differences in accuracy between the hand coded and automatic coded data. Overall, it was determined that there is no significant difference ( $p>0.05$ ) between the hand coded data and automatic coded data for the chocolate or cereal planograms, which are graphical representations of the attention data of participants. These results are extremely beneficial to researchers, as there is now evidence that the automatic software works for eye tracking studies and thus should be implemented to save time and money.

THE EFFECT OF PHENOLIC COMPOUNDS (BENZOIC ACID) ON THE SUSCEPTIBILITY OF GRAM-POSITIVE AND GRAM-NEGATIVE BACTERIA EXPOSED TO ANTIBIOTICS.

Aman Pitalia

Spring Valley High School

Mentor: Xiaoming Yang, University of South Carolina School of Microbiology

Benzoic acid is a common phenolic phytochemical found in the natural environment. This phenol has been found to increase the susceptibility of resistant microbes, making it more feasible to kill the microbials by antibiotics. The experiment modeled the effects of phenolic acids by placing them into an agar medium and exposing them to gram-positive and gram-negative bacteria. The antibiotics [Bactrim and Ciprofloxacin] discs were placed on the top of the agar medium and then the inhibition zone was measured after 24 hours to determine the antimicrobial effects of the phenols. It was hypothesized that higher concentrations of phenols would increase the susceptibility of the microbe, allowing the antibiotics to inhibit the gram-positive and gram-negative bacteria. The groups consisting solely of the antibiotic and bacteria served as a controls for the experiment. The concentrations of the phenols in the experimental group increased at similar levels for each phenol, from 0 µg/ml- 800 µg/ml. The hypothesis was partially supported. The gram-positive microbe *Staphylococcus aureus* was sensitized to both CIP and SXT when exposed to benzoic acid concentrations yielding a  $p < 0.01$  at an  $\alpha=0.05$ . Similarly, the gram-negative microbe *Pseudomonas aeruginosa* was sensitized significantly to CIP when exposed to phenol, having a  $p < 0.01$  at an  $\alpha=0.05$ . In comparison, gram-negative microbe *Escherichia Coli*, proved no statistical significance with a  $p > 0.01$  at an  $\alpha=0.05$ . Conclusions were not drawn in comparison to both strains of bacteria, but evidence suggests that bacteria can be sensitized with benzoic acid, as indicated by the successes with antibiotic application.

A LITERATURE REVIEW OF PHYSICAL THERAPY FOLLOWING NECK DISSECTION IN HEAD AND NECK CANCER PATIENTS

Emily Pope

Governor's School for Science & Mathematics

Mentor: Terrence Day, Medical University of South Carolina

Physical therapy is typically recommended for patients who have undergone a neck dissection, a common surgery performed on head and neck cancer patients to remove enlarged lymph nodes. Head and neck cancers are becoming increasingly common due to the rise in HPV positive oropharyngeal cancer. There is currently no uniform treatment or standard set of exercises given to patients, so this study is designed to look at the most effective therapy through a review of the scientific literature on PubMed. There is an insufficient number of studies to allow for significant findings, however overhead exercises have been shown to be the most effective based on the few studies that exist on the topic. The literature did illustrate that there are other ways to manage pain such as acupuncture and massage in place of, or in addition to, physical therapy.

THE EFFECT OF GREYWATER ON THE GROWTH OF *LEPIDIUM SATIVUM* AND SOIL QUALITY

Kathleen Powers

Heathwood Hall

This experiment studied the effect of greywater on the growth of *Lepidium sativum*, garden cress, and soil quality. 54 pots were filled with 3 ½ inches of soil and 25 garden cress seeds were sprinkled in each pot. The pH of the soil was taken using a pH meter before watering started. 27 pots with seeds were watered with greywater and 27 pots with seeds were watered with tap-water every other day for 16 days. The average height of growth was measured for each water type with a ruler every other day. Final pH measurements and hydrophobicity tests were conducted 5 days after watering finished. To determine hydrophobicity, .3 inches of soil had individual drops of water released onto the surface. If water was not immediately absorbed, it is hydrophobic. The hydrophobicity test was run for each pot. It was hypothesized that the growth of greywater and tap-water samples would have no significant difference, soil exposed to greywater would have a higher pH than soil exposed to tap-water, and greywater soil would be hydrophobic. The results supported part of the hypothesis because there was no significant difference between growth of plants watered with greywater and plants watered with tap-water, the soil exposed to greywater had a higher final pH than the soil exposed to tap-water, but neither soil group was hydrophobic which is contrary to what was hypothesized.

THE EFFECT OF PEER TUTORING ON THE NARRATIVE COMPOSITION SKILLS OF REMEDIAL LEVEL ENGLISH STUDENTS

Kelsey Pratt

Chapin High School

Peer tutoring is an instructional approach through which students are able to enhance their skills in an individualized environment (Holt, B, 2012). In a recent study that aimed to make classrooms more aware of diverse learning styles, peer tutoring programs were implemented throughout twelve schools. Following fifteen weeks of intervention, it was found that students of various "learner types" were able to demonstrate higher scores on a Comprehensive Reading test in comparison to the control group. This research answers the question of whether or not peer tutoring has an effect on the narrative essay composition skills of remedial level English students. Due to the fact that a 2011 State of College Admission Report found that a number of universities considered the college application essay to be of moderate or considerable importance, narrative comprehension and writing abilities were developed as a way to prepare the students for college writing (Clindedinst, Hurley,

& Hawkins, 2011). Over the course of three weeks, six students from and English III College prep classroom at Chapin High met in a controlled environment. They were able to analyze three student model narratives in order to gain an understanding of the essays' structure and purpose. Eventually, they composed their own narrative after learning how to utilize the devices at work within each of the model essays. The comparison of narrative pre and post tests revealed a 0.0516 p-value, and an essay score average of 11.17 out of 25 compared to 6.25 out of 25 from the control group.

#### THE EFFECT OF ORGANIC LABELING ON TASTE PERCEPTION

Caroline Quan  
Heathwood Hall

The purpose of this experiment was to examine the impact of organic labeling on taste perception. The organic market is growing, therefore the use of organic labels, or eco-labels, are also increasing. The results of this study show how the use of organic labels can change the way people taste two identical pieces of food. The subjects used were asked to taste two identical, conventional brownies, one was labeled "organic," one labeled "non-organic," then asked if they preferred the taste of the "organic" brownie, the "non-organic" brownie, or if they tasted the same. The results of this experiment supported the hypothesis; if conventional food is portrayed as organic, then people will taste a difference. In conclusion, this experiment will educate and help people understand the impact of organic labeled food on their taste perception.

#### HANDS-FREE RELEASABLE LEASH

Bethany Quinton  
Center for Advanced Technical Studies

The problem with traditional dog leashes is the fact that owners tend to use them in hazardous ways, such as wrapping the leash around their wrists and pulling, which can result in injuries to both the dog owner and the pet. By eliminating the factor of a wrist injury and also incorporating a hands-free release, injuries caused by dog walking will be greatly decreased with the use of the engineered hands-free releasable leash. The methods used to conduct this engineering project include research concerning force, mainly what force is detrimental to the average person. Following research, a prototype will be made first with snaps and paracord. After testing this prototype with the aid of classmates, a second prototype with a releasing clip as opposed to snaps will also be made and later tested. Hopefully the final product will be usable on a day to day basis and will surpass the traditional dog leash. To analyze the data I will be given feedback from volunteers willing to test out the invention. Once the invention is finalized it will be patented. Potentially if the leash works effectively, I could sell the idea and it would be mass produced. Futuristically, the handsfree releasable leash can be altered and advanced upon based on owner's age and therefore bone health and also the size of the dog therefore changing exerted force.

#### THE DEVELOPMENT OF A PGG LOADED POLYMER BASED VESSEL GRAFT

Shelby Rader  
Governor's School for Science & Mathematics  
Mentor: Jorge Rodríguez-Dévora, Clemson University

The current model of vascular graft replacements for the coronary artery focuses on the use of autotransplantations. Over 500,000 coronary artery bypass autotransplants are performed annually. A growing problem with the use of autotransplants is that 1/3 of autotransplant patients lack the vessels necessary for the procedure due to advanced vascular disease or past vessel harvests. The development of a physiologically compatible polymer based cardiovascular device using the electro-spinning technique has the potential to solve this problem. Efforts to construct an electro-spun graft show that a major issue in the development of such a device is elastin degradation. Elastin is an essential protein throughout the body that allows tissues to stretch and recoil. Without elastin, vascular grafts will degrade and decrease the quality of coronary artery function. PGG (Penta Galloyl Glucose) has been proven to increase the preservation of elastin. The goal of this project, therein, is to develop a method to load PGG to biologically compatible polymers such as Stratoprene 3534 and Ingeo-Biopolymer 2003D in order to decrease elastin degradation. The first step towards meeting this goal is testing to see if PGG will bind to the polymer without the addition of an elastin substrate. To test this, a standard curve for PGG was obtained through the application of a Ferric Chloride Assay and several more assays were performed with the addition of the polymers. The results of the assays with the polymers showed that PGG will not bind to the polymers by itself.

#### DISPARITY BETWEEN BUILD TIME ESTIMATION AND ACTUAL PRINT TIME IN THE PROJET MJP 3600 PRINTER SERIES

Jacob Rains  
Governor's School for Science & Mathematics  
Mentor: Karuna Kataria, 3d Systems

It is found across all types of 3D printers that there is a discrepancy between the estimated build time of a part and the actual build time of the part. The main cause is difficult to locate, as there are many variables, and so this study attempted to find the root cause of the discrepancy between the 3D Systems ProJet MJP 3600 series and the Client Accelerator used to submit builds and estimate the build time. In many cases, the difference between the Build Time Estimate (BTE) and the actual time is under 10%, but there are a few occasions where the BTE of a part is above 40%. In order to locate the source of this error, a

large number of parameters were recorded and their correlation with the difference was tested. It was found that there was an unauthorized pause time in between the part layers, and that time was not calculated in the BTE. That unauthorized time varied, and so the same parameters were compared to the variance in the extra build time per layer in order to find any correlation between the two. It was found that the parameters tested did not have any correlation with the discrepancy, and therefore the parameters measured were not the root cause.

#### THE SYNTHESIS AND CHARACTERIZATION OF CORANNULENE-BASED METAL-ORGANIC FRAMEWORKS

MaryGrace Rainsford

Governor's School for Science & Mathematics

Mentor: Natalia Shustova, University of South Carolina Columbia

Due to the great demands within the energy community, the need to develop materials that can significantly alter the vitality of different substances is one of the top priorities of researchers. In recent years, metal-organic frameworks (MOFs) have been synthesized to potentially be used as these advances. The objective of this project is to specifically alter the synthetic route of corannulene-based MOFs to create a new anode for a Li-ion battery used in hybrid cars. Due to the crystalline materials porosity and high surface area, the rate performance of this battery can effectively be improved. To do this, a three step synthetic route resulting in dimethyl 5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)-isophthale was proposed with the goal of successfully improving the anode material for Li-ion batteries as compared to the previously used graphite. The crystals were tested for crystallinity using nuclear magnetic resonance (NMR). Results from the NMR graphs from each step of the synthetic route convey that the desired crystals were successfully made with the correct alignment of hydrogens throughout the product. From this work it can be deduced that additional work with corannulene-based metal-organic frameworks is promising because of their advantageous properties. In the future, the viability of its synthetic route can continue to be improved so it can be used within even more applications.

#### THE EFFECT OF OMEGA-3 PUFAS ON *ENTEROBACTER AEROGENES*

Alejandra Ramirez

Spring Valley High School

Omega-3 polyunsaturated fatty acids (PUFAs) are lipids composed of two or more carbon double bonds in a hydrogen chain with the double bond at the third carbon atom. These fatty acids have shown anti-inflammatory characteristics along with health benefits to the human body. On the contrary, *Enterobacter aerogenes* is a gram-negative bacteria, protected by a layer of lipopolysaccharides, that is known to be a bacterial pathogen that is resistant to antibiotics. In this experiment, the gram-negative bacteria, *Enterobacter aerogenes*, was exposed to a 0.05 mL concentration of three different types of omega-3 PUFAs. The three omega-3 PUFAs used were alpha linolenic acid (ALA), eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA). It was predicted that DHA PUFA would be the most effective in inhibiting the growth of the *Enterobacter aerogenes*. Experimentation was accomplished by mixing each acid with liquid broth into different test tubes and then their optical density at 600.10 nanometers was recorded. The hypothesis that one of the means would be different was not supported. At  $\alpha = 0.05$ , when  $p < 0.1153$  and  $F(3,119) = 2.02$ , there was no significant difference between the means. It was concluded that the omega-3 PUFAs were not significantly effective in inhibiting the growth rate the *Enterobacter aerogenes*.

#### THE EFFECT OF GLYPHOSATE AND GAMMA CYHALOTHRIN ON THE TOTAL NUMBER OF VIABLE *DAPHNIA MAGNA* AND THE AVERAGE NUMBER OF OFFSPRING PER *DAPHNIA* SPECIMEN

Bridgette Ravindra

Spring Valley High School

If chemicals leach into local water supplies and groundwater through irrigation systems and runoff, they can harm aquatic organisms, such as *Daphnia magna*. This research assessed the results of these chemical substances and how they could affect *Daphnia magna* in the surrounding environment. It was hypothesized that *Daphnia magna* exposed to systemic products, rather than contact products, would yield the highest average reproductive rates and the greatest survivorship of adult *Daphnia* specimens. There was a control group, Compare-N-Save Concentrate Grass & Weed Killer (glyphosate, systemic) group, and Spectracide Triazicide Insect Killer (gamma cyhalothrin, contact) group. The total number of viable adult *Daphnia* specimens and the average number of offspring reproduced per adult *Daphnia* were recorded daily until all of the organisms died. A multivariate test was run with  $F(12,166) = 6.248$   $p < 0.05$  Wilks'  $\Lambda = 0.475$ , partial  $\eta^2 = 0.311$  to find that the herbicide or pesticide/concentration had a significance of .000, and from there, a one-way MANOVA test was run for the two dependent variables. After the MANOVA was run, a post-hoc Scheffé Test was conducted at  $\alpha = 0.05$  to determine where there was a significant difference between the herbicide or pesticide/concentration and the average number of offspring reproduced, and a Tamhane-T2 test was run for the total number of viable *Daphnia magna*. Grouping information using the Scheffé Test showed that significant differences lie between 5 pairs of means for the average number of offspring, while the Tamhane-T2 test showed only 1 difference in means for the number of viable *Daphnia*. The hypothesis that the systemic product would result in more offspring and greater survivorship was not supported because the glyphosate had the lowest average number of offspring reproduced, and 2 out of the 3 glyphosate groups had averages of 0 offspring.

## RELATIONSHIP BETWEEN THE EXPRESSION OF PGC-1A AND MUSCLE FATIGUE IN APCMIN/+ MICE.

Matthew Re

Governor's School for Science & Mathematics

Mentor: James Carson, University of South Carolina Columbia

Cancer cachexia is defined as severe muscle wasting due to cancer and affects 30%-80% of all cancer patients depending on their type of tumor. One of the leading causes of a poor quality of life in cachexia patients is the muscle fatigue that is associated with the muscle wasting. Previous work has yet to address whether there is any connection in the expression of the PGC-1 $\alpha$  protein, a key regulator in mitochondrial biogenesis, and the rate of fatigue in these cachectic patients. We hypothesize that if the rate of mitochondrial biogenesis is increased, shown by an increase in PGC-1 $\alpha$  expression, then the rate of fatigue in the muscle will decrease. Numerous tests were run on ApcMin/+mice in order to examine whether there is any correlation between muscle fatigue and mitochondrial biogenesis. A Western blot was used to examine the expression of PGC-1 $\alpha$ . Following this, the ApcMin/+ mice were then subjected to an in situ muscle function analysis in order to test the strength output capabilities of their leg muscle and the rate at which the muscles fatigue. Mitochondrial biogenesis in cachectic mice was increased in these mice, while no distinguishable difference was observed in the rate of muscle fatigue in cachectic and healthy mice. These findings may lead to a better understanding of the effects of cancer cachexia, as well as insights into improving the quality of life for the cancer patients.

## WHAT IS THE CORRELATION BETWEEN POOL CHEMISTRY AND A SWIMMER'S HEALTH?

Lily Richter

Heathwood Hall

The purpose of this study was to determine the relationship between the chemicals in swimming pools and the swimmer's health. It was hypothesized that if the pool chemistry and a swimmer's health are monitored, there will be a correlation. The five main elements for testing water quality in swimming pools in the United States include testing free chlorine, total chlorine, bromine alkalinity, pH, and hardness levels. Over the course of 11 days, the pool chemistry in the competition pool at the University of South Carolina was tested using pool test strips. After the pool chemistry was tested, swimmers were asked to fill out a survey about certain health symptoms that they experienced while swimming in the pool. After analysing the data, it showed that when the pool's chemistry was within the optimum levels, the amount of health issues (i.e. itchy skin or eyes, earaches, or respiratory issues and cough) decreased and when the pool chemistry was outside the optimum levels, the amount of health issues increased.

## ANALYZING THE EFFECT OF WHEY PROTEIN TIMING ON BENCH PRESS MAX

Garrett Ringer

Chapin High School

Whey protein has been proven to increase body cell mass (BCM), as well as slightly improving the amount of strength gained in adult men and women. However no studies have been conducted in regards to teens, or the timing of the whey protein intake. Many current weightlifting articles and research has been conducted involving adults (ages eighteen and older). As adolescent lifters look for reliable information it can be hard to cipher between data and information regarding older lifters or data regarding teen lifters. This project answers the question "What is the optimum time to intake whey protein to maximize an increase in the one-rep bench press max in teenage boys? (ages 14-18)". The goal of this project is to provide useful, up to date, and reliable information to teen lifters. Weightlifters from local gyms and weightlifting teams will be surveyed bi-weekly in order to track an increase in their bench press as well as what brand of protein and when they are taking the protein. In conclusion, this project proved that if whey protein is consumed within ten minutes of a workout then the participant will have a 5% greater increase in strength than any other timing of the intake.

## THE RELATIONSHIP BETWEEN GRADE LEVEL AND THE STROOP EFFECT

Faith Robertson

Heathwood Hall

The purpose of this experiment was to test the relationship between grade level and the Stroop effect. The goal was to find out whether or not the Stroop effect is caused by a cognitive interference between the second nature of reading and the color identifying processes. (Besner et. al. 1997) The Stroop effect is the automatic brain process of humans' tendency to name the word as it reads, rather than the color ink of the word. For example, if the word "orange" is printed in green ink, it is much more difficult to identify the color of the ink, green, than the color the word reads, orange. This is an example of an incongruent word. When the word and ink color are the same color, it is known as a congruent word. The test subjects were in ninth grade, second grade, first grade, kindergarten, and 4 year-old preschoolers. By testing younger students, the second nature of reading was eliminated, so it was hypothesized that younger students would take longer identifying congruent words, but be quicker than older students in identifying incongruent words. However, the results are a stark contrast to the hypothesis because in this study ninth graders had shorter times in all categories. This result questions the commonly believed theory that the Stroop effect is caused by a cognitive interference.

## EFFECTS OF VARIABLE PRESSURE ON NEWTONIAN AND NON-NEWTONIAN MICROFLUIDIC FLOW

Wes Robinson

Governor's School for Science & Mathematics  
Mentor: Xiangchun Xuan, Clemson University

In this experiment, the vortical flow effects caused by variable pressure were investigated in microfluids, both Newtonian and non-Newtonian, as they passed through a constriction in a microchannel. It is becoming increasingly important for us to study such interactions as the field of microfluidics expands. Biomedical researchers simulating blood flow in a lab-on-a-chip, or even product designers in the inkjet printing industry could benefit by knowing that these particular interactions occur, as a vortex appearing could cause unforeseen issues in a micro-scale environment like a capillary or tube of ink. Knowing when and why these vortices occur can allow such researchers to avoid or utilize them. It is also important to compare and contrast the flows of Newtonian and non-Newtonian fluids, the latter of which consists of a wide variety of fluids that all behave differently depending on the situation. Through studies such as these, the practicality of using either fluid at the microscopic scale can be further assessed and their unique advantages fully harnessed according to the needs of their application. This experiment was approached by fabricating microchannels, each containing a constriction where channel width abruptly decreased by 90% for a short length, and using a syringe pump to push samples of both fluid types through it at incrementally increasing pressures. It was shown that regardless of fluid type, there is a positive correlation between flow pressure and vortex dimension. In addition, several qualitative differences were observed between the Newtonian and non-Newtonian vortices.

## HOW DO TRAITS DIFFER BETWEEN GMO AND ORGANIC APPLES, POTATOES, AND CORN

Ava Rosenbaum, Molly Caballero and Lucy Derrick  
Heathwood Hall

The purpose of this project is to determine if there is a difference between taste, appearance, glucose level and daily decrease in mass and diameter of genetically modified and organic apples, potatoes, and corn. The reason this is being researched is because many people are switching to eating only organic fruits and vegetables without knowing all the facts. The tests that are being performed are taste and appearance, rate of decomposition, and the glucose level. The decomposition will be measured by how much the diameter and mass decreased per day over a 2 week period. These tests will be performed on both the organic and genetically modified fruits and vegetables. The hypothesis is that there will be a significant difference between taste, appearance, glucose level, and daily decrease in mass and diameter of GMO and organic apples, potatoes, and corn. The null hypothesis is that there won't be a significant difference between taste, appearance, glucose level, and daily decrease of mass and diameter of organic and GMO apples, potatoes, and corn.

## OPTIMIZATION THE PRODUCTION OF BIODIESEL

Noah Rowell

Center for Advanced Technical Studies

Biodiesel is currently 5-10% less efficient than diesel depending on what type of blend used. If the student tests the difference in the two step catalyst percents mixture then the student will see that an 80:20 mixture will be the most efficient. The student tested if there was a difference in the efficiency in the two stage catalyst mixture for biodiesel. This was done by acquiring baseline data by putting 100% of the catalyst in the first 3 batches. After this the catalyst was taken down when initially put in by 10% so a 90:10, 80:20, 70:30, 60:40, 50:50 and 40:60 mixtures were used. The data received showed that there was a difference in the efficiency of percents when mixing the catalyst into the waste vegetable oil. The data collected showed that a 40:60 and 80:20 mixtures proved to be the most efficient based on the averages. The hypothesis was proven to be incorrect from the data acquired. This data will help to find the more efficient form by giving a starting point for what percent of catalyst to use.

## TRANSFER ENTROPY WITHIN THE NASDAQ STOCK EXCHANGE

Caleb Rummel

Governor's School for Science & Mathematics  
Mentor: Kyuseong Lim, Korea Advanced Institute of Science and Technology

Using Transfer Entropy, we attempt to compare information flow between varying industries and the economy as a whole through studying 153 companies in the NASDAQ Stock Exchange and the NASDAQ Composite as an economic indicator. Transfer Entropy provides a model-free approach to detect asymmetrical statistical dependencies and correlations allowing us to calculate both the magnitude and direction of information flow. A delay variable is introduced to determine which industries tend to lead mass movements in the stock market, as well as to characterize the duration of influence leading these movements. Using a time series from 1 January 2000 to 20 July 2016, we perform a time-series analysis between each individual company and the NASDAQ Composite. Our data suggests that the consumer durables and finance industries provide the most information concerning the economy as a whole. Using a one-day delay, we find that introducing a delay variable significantly increases Transfer Entropy of all industries aside from energy, with technology having the most significant increase (103%), compared to the average (28%). After a one-day delay, we find that additional delay decreases Transfer Entropy generally, but not monotonically, suggesting that movements are mostly influenced by two-day trends. The introduction of a delay variable to studying information flow allows us to expand the applications of Transfer Entropy in

econophysics, specifically the ability to determine not only magnitude and direction, but also duration. From this, we are able to better understand what leads market movements such as the 2009 global financial crisis.

#### FILE COMPRESSION USING HUFFMAN CODING WITH VARIOUS BIT LENGTHS

Jeffrey Russell

Governor's School for Science & Mathematics

Mentor: William Thacker, Winthrop University

One of the earliest and most widely used types of file compression is known as Huffman Coding. It compresses files by assigning short binary values to the most frequent groups of eight bits in the file, and becomes more efficient as the frequencies of these groups becomes less uniform. This research aimed to use groups of bits of lengths other than eight in Huffman Coding. Compression ratios were calculated for the compressed file in relation to the original file. This was done in order to determine which bit length had the best compression for text files, image files, and executables. In general, text files compressed most efficiently at multiples of eight bits; image file compression varied based on image content rather than on bit length, but in general did not compress well at lengths less than or equal to eight bits; and executables compressed most efficiently at eight bits.

#### HOW DO ANXIETY AND DEPRESSION SYMPTOMS RELATE TO ACADEMIC SELF-EFFICACY AMONG ADOLESCENTS?

Malik Sanders

Governor's School for Science & Mathematics

Mentor: Kate Flory, University of South Carolina Columbia

This study examined the relationship between affective disorder symptoms such as depression and anxiety, and self-efficacy in adolescents. Self-efficacy is defined as one's belief in one's ability to succeed. The hypothesis was that students who showed a higher number of affective disorder symptoms would have low self-efficacies. To start the project, a small sample of students were selected from a random county in South Carolina to be screened for behavioral disorders and ticks. Once the students were screened, their families were contacted so that they could participate in a series of interviews that gauged risky behaviors, tics, self-efficacy, and affective disorder symptoms. The data from the interviews were then logged into a software package called PLAY. A few statistical analyses were run on the data dealing with self-efficacy and affective disorder symptoms. The results of those analyses were that students in middle and high school who showed a high level of affective disorder symptoms had lower self-efficacies. The results also showed that this relationship was completely inverted with elementary school students, meaning that when they exhibited affective disorder symptoms they also exhibited high self-efficacies.

#### EXPLORING THE ANTIOXIDANT PROPERTIES OF *PANAX QUINQUEFOLIUS* AND ITS COMPONENTS

Shakthika Saravanan

Spring Valley High School

Mentor: Lorne Hofseth, University of South Carolina Columbia

Around 93,090 cases and 49,700 deaths, resulting from colorectal cancer, were estimated for 2015 ("Cancer facts and figures 2015," 2015). This study focused on ulcerative colitis induced colon cancer which are promoted through inflammation. The purpose of this study is to observe what component of american ginseng allows the anti-inflammatory pathway to open up. It was hypothesized that whole ginseng would decrease the number of reactive oxygen species the most, only because hexane fraction IV and panaxynol are being used. However, only based on the extracts, the panaxynol will decrease the most reactive oxygen species and the immunofluorescence will show more nrf2 outside of the nucleus of the ANA-1 cells. The study was performed by treating ANA-1 cells with whole ginseng, hexane fraction IV, and panaxynol for 0, 1, 2, or 3 hours and then irritating them with interferon gamma for 24 hours. An immunofluorescence was then conducted to observe the location of the Nrf2 for each designated treatment. In the luminescence portion of the experiment, the trend displayed was that the whole ginseng decreased the most inflammation as the time treatment increased. However, out of the extracts, the panaxynol decreased the most inflammation as the time treatment increased. The immunofluorescence portion of the experiment showed that the Nrf2 was predominantly expressed and dispersed outside the cell for the panaxynol. The purpose of this study was to observe what component of american ginseng allows the anti-inflammatory pathway to open up.

#### THE EFFECT OF COMPOUND AND METALLIC COATINGS OF GRAPHITE, SILVER, TIN OXIDEM AND COPPER ON THE ABILITY OF A PIEZOELECTRIC DISC TO BOOST ITS PRODUCTION OF PIEZOELECTRICITY AFTER TENSILE FAILURE

Nithin Saravanapandian

Spring Valley High School

Piezoelectric devices can break from too much stress, causing tensile failure. When in complete tensile failure or fracture, piezoelectric devices need to be replaced. In order to try and fix this problem, the idea of using metallic or compound coatings over the areas of tensile failure was proposed. The four different materials used were silver, graphite, tin oxide, and copper. The hypothesis for this research project was that if graphite were used, it would be the best coating for the piezo discs because

it contains graphene, which is very flexible and highly conductible. The piezo discs were first studied under a microscope, and each broken with a machinist's vice to simulate tensile failure. The electricity production was then measured with a multimeter at the setting of 200V DC. After the results were recorded, the coatings were made by mixing two grams of every material with acrylic paint. These paints were then spread on certain piezo discs, and then tested for piezoelectricity again. The differences between these two data sets were calculated to test if the coatings were effective. The results can be seen in Figures 6-8 in the Appendix. An ANOVA test ( $F(4,85)=1.27$ ,  $p=0.29$ ) was used to test the significance of the results, the p-value was 0.29, which was greater than the alpha value 0.05. This means the null hypothesis was not rejected, and it can be concluded that there were not any significant differences between the different groups of piezo discs.

#### DIGITAL VILLAGES: CREATING A STABLE BACK-END PROGRAM FOR A CROWDSOURCED IMAGE APPLICATION

Jacob Sargent

Governor's School for Science & Mathematics

Mentor: Steffen Hupp, Fraunhofer Institute for Experimental Software Engineering

Digital Villages is a project movement that seeks to build relationships within communities. Some apps in this movement are in development. These apps perform tasks such as job offerings and local trades. The goal of Digital Villages: Discoverable is to connect villagers with their pasts by having them upload old pictures of spots around a village for everyone to see. For this project, the back-end of the application was developed. The back-end contains the source code that will run on the server, rather than on the client's phone, and it will connect the user with online databases of images and information. For this back-end, Spring REST framework creates an environment where variables are omnipresent. For the application to be effective, the back-end was coded as a Java application where users can upload their images and descriptions to various sites of cultural significance.

#### USING FIBER BRAGG GRATINGS TO DETECT DAMAGE IN METAL PLATES

William Schmidt

Governor's School for Science & Mathematics

Mentor: Lingyu Yu, University of South Carolina Columbia

Many aircraft in both the private and public sectors are facing serious aging issues. In the interest of making these aircraft as safe as possible and reducing maintenance costs, it is necessary to detect damage as early as possible. However, traditional methods often fail at early detection, especially in the case of composites, which are a principal building material of aircraft. The proposed solution is to pair fiber Bragg gratings (FBGs) with piezoelectric wafer active sensors (PWAS). PWAS produce guided ultrasonic waves (GUWs), which are then received and converted to an analog electrical signal by FBGs. Three procedures were performed with PWAS and FBG. The first was a directionality test, used to establish a baseline for the mechanics of GUV based damage detection. The second was a sensitivity test, which measured the effect of changing the orientation of a PWAS relative to the FBG and testing a signal difference. The final procedure was a classic damage detection problem, in which an obstruction was placed on the plate and the reflections emanating from this damage source were isolated. Results of the first procedure closely matches the results of previous studies, suggesting that the PWAS and FBG were set up correctly in that case and in future procedures. For both the second and third procedure, increasing frequency consistently correlated with decreasing signal to noise ratio. The data appears to imply that lower frequencies are better for damage detection, but further research is needed.

#### SIZE MINIMIZING STRATEGIES FOR REMOVING OF REDUNDANT EXPRESSIONS FROM A SUPERSSET

David Schmitt

Governor's School for Science & Mathematics

Mentor: Chris Healy, Furman University

A British gameshow titled "Countdown" has contestants generate mathematical expressions using arithmetic operations and a randomized set of values. The goal is to generate an expression which evaluates nearest to a target quantity given a random set of operators. To simulate contestant's answers permutations and other strategies generate an exhaustive superset of possible solutions for the given parameters. However, the solution set is huge, filled with redundancies, and needs to be pruned. Our research identified and removed unnecessary expressions based on associativity and commutativity, and further defined a process for deleting operations that nullify a previous operation. The minimized list of expressions will be used for future research on the relative difficulty of evaluating each of these expressions for humans.

#### THE EFFECT OF GLUCOSE ON THE LACTASE ENZYME

Riana Shelly

Heathwood Hall

The purpose of this study was to determine the effect of dairy and 'lactose-free' products with respect to the amount of glucose and/or galactose. Seven types of milk were tested: three soy milks, three whole milks and one plant based milk. The most natural way for lactose intolerant people to comfortably consume lactose is by an extra presence of glucose in the dairy product, but many times companies modify their products differently, for different reasons. Each milk was tested five times: three times at the initial temperature, once with a lactase supplement drop, and once at room temperature. Almost every

time, the supplement and temperature change did not give a different outcome than the trials previously. The milk was tested with a glucose strips used primarily for diabetes. The strip was dipped in the milk, exposed to the air for thirty seconds and the color of the strip was compared to the scale on the side of the bottle. The scale used percentage as the form of measurement, going from 0% to 5% with  $\square\%$ ,  $\frac{1}{2}\%$ , then counting up by one. The hypothesis of this study is if the dairy products are lacking lactose, then the glucose strips will not be positive (to some percentage). The hypothesis was supported by the experiment. In conclusion, lactose intolerant people will benefit by knowing which products have the most glucose.

#### ANALYSIS OF SNELLEN VISION TEST VERSUS PICTURE TEST DATA COMPARISON

Alyssa Sheppard  
Chapin High School

The Snellen vision test was developed in the 1860's to test for vision acuity, meaning clarity of vision. Blurry vision is the loss of sharpness in eyesight, making objects appear out of focus and hazy. The line for standard human vision is 20/20, which means a person can read the line from 20 feet and are considered to have "normal vision". The Snellen test has been modified over the years, yet contains various discrepancies which compromise the results. The lines testing for poor vision have only 1 to 2 letters, while lines testing for good acuity have 8. The project is the comparison of two vision tests, one the standard Snellen and a Picture test used for preschoolers, to determine if an individual scores differently on the same line. Each participant will read the 20/20 line, and the score will be recorded for each test in a spreadsheet. The project determined if reading the same line, 20/20, produces different results between two tests. Data showed that there was no instance where the tests produced the same results on the 20/20 line, with a p-value of .017 there is a significant difference between the eyesight being measured between the picture and the snellen method.

#### COMPOSITION OF STAINLESS STEEL BY AUGER ELECTRON SPECTROSCOPY

Matthew Siden  
Governor's School for Science & Mathematics  
Mentor: Chad Sosolik, Clemson University

Many people today rely on nuclear energy, and a major component of working with this involves dealing with materials that undergo nuclear decay. This makes it increasingly important to be able to contain radioactive emission particles reliably. For any object being exposed to emission particles, given enough time it will develop microscopic cracks on its surface, and the material will degrade. This makes it difficult to work with radioactive materials because infrastructure must be replaced often. The Savannah River National Lab (SRNL) wishes to develop a material that can resist this degradation longer than any current material. To do this, they're preparing samples of stainless steel differently, then sending them to Clemson University's Kinard Laboratory in order to have the composition tested. This testing is done by Auger Electron Spectroscopy, a method of determining the elemental make-up of a substance which relies on the Auger Effect. One sample in this experiment saw a significant decrease in the composition of carbon (approximately 90%), while it saw a small increase in the carbon and iron as the depth increased. Future work would examine identical samples exposed to decay particles to test their resolve.

#### DOES THE SPORT AND ATHLETE PLAY AFFECT THE WAY THEY THINK

Erin Siegfried and Anna Jowers  
Chapin High School

*No Abstract Text Submitted*

#### REAL VS. ADVERTISED CAPACITY AND CAPACITY FADE IN LITHIUM ION 18650 BATTERIES

Lee Sighler  
Center for Advanced Technical Studies

For this research project, the purpose is to find if there is any difference between the milliamp hour rating labeled on the battery compared to discharging the battery and calculating the milliamp hour spent during a 0.5C rate discharge (for Imax B6 Mini); along with measuring capacity fade and temperature of chinese made 18650 lithium batteries. Lithium ion batteries are important since the batteries are used with electric vehicles. Fossil fuel availability is declining for the transportation industry and a need for new transportation independent from fossil fuels is vital. If lithium ion 18650 batteries are discharged experiencing high temperatures and a high C rate, then the battery will be more susceptible to thermal runaway and will show a more significant capacity fade. A 0.5C rate discharge for the 18650 batteries used equates to discharging the battery with a current of 1.3 amps because the milliamp hour rating for all 18650 batteries in the project are rated 2600 milliamp hours. The battery is then discharged to its specified end voltage depending on the number labeled on the battery. The mAh at the end of the discharge is divided by the C rate to calculate actual mAh. The two total mAh are converted to coulombs for comparison. To measure the capacity fade with the HP 34401A multimeter, each type of battery is tested by ending at different depth of discharge percentages and C rates. Then the data is graphed to show capacity variation. Olight(2) lost 4.7% capacity/ max temp. 45 Celsius, Nitecore(2) lost 8.5% capacity/ max temp. 47 Celsius, Ultrafire(2) lost 9.7% capacity/ max temp. 50 Celsius. Data from HP 34401A multimeter(0.8C rate avg.) Olight(4) lost 5.9%, Nitecore(4) lost 9.3%, and Ultrafire(4) lost 10.5% capacity after 5 discharge/charge cycles.

## DETERMINING THE DEGRADATION ALONG THE LENGTH OF QUARTER INCH POLYESTER URETHANE MAGNETIC TAPES USING ATR FT-IR SPECTROSCOPY

Caleb Simpson

Governor's School for Science & Mathematics

Mentor: Stephen Morgan, University of South Carolina Columbia

Throughout the country, libraries and museums have audio recordings. These recordings are stored on magnetic tape, which are made of polyester urethane. The polyester urethane serves as the magnetic particle binder for the tape. Still, the tapes are degrading. These tapes hold important cultural and historical information that will be lost if they are not digitized. A research team at the University of South Carolina, led by Dr. Stephen Morgan, is working on coming up with a quick process to determine the playability or nonplayability of each tape. The audio tapes donated from the Library of Congress are quarter inch tapes. The importance of finding a quick and reliable process is to be able to help stop the destruction of the tapes during playback. Playback is the current method of determining whether the tape is playable or not. Tapes acquired from the Library of Congress were analyzed using attenuated total reflectance Fourier transform-infrared spectroscopy (ATR FT-IR). ATR FT-IR provides, using algorithms, the functional groups of the tape on a spectrum. Also provided is their location on the spectrum using wavenumbers which are measured in  $\text{cm}^{-1}$ . After this, testing was done on a vintage tape player. These two tests returned results saying the tapes were playable. Finally, the tapes were put into the MATSA program. This compared similarities and difference of the tested tapes to a reference set. This told us the tapes were nonplayable. This meant the tests needed to be repeated to ensure maximum accuracy was obtained.

## THE BIODEGRADATION OF POLYETHYLENE FOAM VIA TENEBRIO

Jasdeep Singh

Spring Valley High School

Plastic's properties tend to produce polymers that are resilient towards environmental degradation factors. This results in the accumulation of plastics in the habitats of biological communities, which constitutes as pollution. However, even with plastic's antidegradation properties, mealworms have presented promising results when it comes to the biodegradation of polystyrene, one of the most commercially employed plastics available. The purpose of the study was to analyze the biodegradation of polyethylene foam through mealworms, more specifically, *Tenebrio*. The change in mass of the polyethylene, measured in grams, was observed in coordination with the change in mass of the mealworms themselves. It was hypothesized that the mealworms would be able to significantly biodegrade the polyethylene foam, and that there would be no significant mass differences between the mealworms biodegrading the polyethylene foam and the mealworms consuming a bran-only diet. 10 mealworms were placed into chambers containing polyethylene foam and chambers containing bran meal. There was also another set of chambers that only contained polyethylene foam. After 14 days, there was a significant difference in the change in mass between the polyethylene masses. When two samples t-tests were performed,  $t(2)=-3.148$ ,  $p=0.0878$  was produced for the polyethylene mass change, and  $t(2)=-6.25991$ ,  $p=0.004$  was produced for the mealworm mass change. It was concluded that mealworms were able to substantially biodegrade the polyethylene foam sheets. However, they had a lower collective mass compared to mealworms consuming a bran meal diet.

## MODELING OF HYDROGEL RHEOLOGY IN APPLICATIONS FOR LUNG MUCUS

Greylan Smoak

Governor's School for Science & Mathematics

Mentor: Paula Vasquez, University of South Carolina Columbia

Lung mucus plays an important role in the human body by ridding it of foreign particles. Under different conditions it exhibits unusual properties that are poorly understood. Modeling lung mucus will provide researchers with a better understanding of its rheological properties and provide insight into how to treat mucus related illnesses such as cystic fibrosis. Utilizing high powered computers to simulate small amplitude oscillatory shear flow we are able to examine the rheological behavior of lung mucus. In order to ensure that the data produced by our simulation contains little error and could be run in a timely manner, we tested different values for the number of cycles and sample points per cycle. In this analysis, noise was added to a sinusoidal wave to mimic the simulated small oscillatory shear output. Through this process, we found an optimal value for the points per cycle and number of cycles. These values will then be used in our simulation to ensure reliable and efficient production of data.

## MITIGATING THE URBAN HEAT ISLAND EFFECT BY UTILIZING COOL ROOFING

Hayden Spencer

Center for Advanced Technical Studies

This research project focuses on testing different types of roofs, all made with different materials, and recording what type of roof works best to mitigate the urban heat island effect. The specific goal of this research project is to run tests which demonstrates that buildings with cool roofs result in cooler interior temperatures, therefore reducing the amount of energy needed to cool the building and reducing the amount of resulting carbon emissions. Tests were run using a small model house with corresponding removable model roofs. Two trials were conducted using four different roofs; Trial 1 focused on comparing the energy usage of a steep sloped black shingled roof with a steep sloped gray shingled roof, Trial 2 set focused on comparing the energy usage of a control black shingled roof with a green roof. The second phase of research focused on comparing the

amount of water runoff between the green and control black roof. Results from Trial 1 showed that on average, the gray shingle roof consumed .22 kWh, and the black .27 kWh, resulting in an 18.51% reduction of energy usage. Results from Trial 2 showed that on average, the green roof consumed .20 kWh, and the control .23 kWh, resulting in a 13.04% reduction in energy usage. When pouring 20.00 L of water on each roof, the green roof had an average runoff of 8.76 L, and the control 19.05 L, resulting in a 51.45% reduction of water runoff and suggesting green roofs have a lower amount of water runoff than traditional roofs.

#### THE EFFECTS OF JOULE HEATING ON ELECTRIC-DRIVEN MICROFLUIDIC FLOW

Alexander Spitzer  
Governor's School for Science & Mathematics  
Mentor: Xiangchun Xuan, Clemson University

This study sought out to more clearly understand the relationship between Joule Heating and fluid flow in microfluidic environments, and more specifically, under what circumstances would the fluid flow in the device possibly hinder an experiment being run on it. It had been previously theorized that an electric field may produce turbulence and even vortices within the fluid, which this study attempted to reproduce. Several variables were tested, namely insulating and conducting fluids, higher and lower AC voltages, Newtonian vs. non-Newtonian fluids, and higher and lower DC voltages. A correlation between these variables and turbulent flow was found, with more conductive fluids, higher AC voltages, non-Newtonian fluids, and higher DC voltages more prone to fluid turbulence.

#### THE CORRELATION BETWEEN COMMON LIQUID CONDUCTIVITY, BLOOD CONDUCTIVITY, AND CRAMPS.

Trevor Squirewell  
Heathwood Hall

The purpose of this experiment was to determine the conductivity of common liquids used by athletes and to see if there is a correlation between the conductivity of the drinks along with blood conductivity and cramps. To begin the experiment, 5 common liquids were chosen: Water, Gatorade, Low Calorie Gatorade, Pickle Juice, and Powerade. These liquids were chosen because they are common liquids used by athletes to quench thirst, replenish electrolytes, and relieve cramps. The conductivity of each of the liquids were tested to see if there was a correlation between electrolytes present and conductivity of drinks. It was hypothesized that the liquid that contained the most electrolytes would have the highest effect on the conductivity reading. The results showed that the liquids that did have the highest amount of sodium and potassium electrolytes also had the highest conductivity reading. This supports the hypothesis. The Gatorade and the low calorie Gatorade had the highest conductivity readings while pickle juice came next. To conclude this means that if one were to have cramps, Gatorade would be the best source of relief.

#### CHANGES IN MAGNETIC NANOPARTICLE SIZE IN DIFFERENT CELL GROWTH MEDIA

Jacob Stokes  
Governor's School for Science & Mathematics  
Mentor: Tzuen-Rong Tzeng, Clemson University

Magnetic Nanoparticles (MNPs) are small metallic particles that can be heated up by exposing them to an Alternating Magnetic Field. These nanoparticles can be targeted to specific cells (such as cancer or bacteria), and eventually the cells are killed through magnetic hyperthermia. For these particles to be effective they must be small enough to remain undetected by the body's immune system. A diameter of 200 nm or less is preferred. While the MNPs are usually under 100 nm initially, interactions with the proteins in the body can alter the size and chemistry, changing the inherent properties of the MNPs. This presents a serious engineering challenge, and in order to make more stable particles, the factors contributing to their instability must be initially understood.

#### THE EFFECT OF PETROLEUM BASED OILS ON THE AMOUNT OF DISSOLVED OXYGEN IN WATER

Kierson Sutton  
Spring Valley High School

A dissolved oxygen sensor tests the amount of dissolved oxygen, in an amount of water. The purpose of this is to show the impact of pollution on water quality. It was hypothesized if alkaline water was polluted with motor oil than the amount of dissolved oxygen present in the water would decrease more than if the water was polluted with diesel fuel. In the current experiment the water was tested with 80 to 100 concentration of an oil to water 32 times for each type of oil. The amount of dissolved oxygen produced was recorded before and after the water was polluted and the measurements were calculated. The independent variables were the type of oil and the dependent was the amount of dissolved oxygen left after the oils were added. The ANOVA test was done with an  $\alpha=0.05$  while  $H_0=\mu_1=\mu_2=\mu_3$ ;  $H_0$  there is a significant difference between the variables (claim). Because the p value was below the  $\alpha=0.05$  A Tukey post hoc test had to be constructed. The F-equation was found to be  $F(3,124)=588.38$ ,  $p < 0$ . There was a difference among all the means, because the confidence intervals did not contain zero. There was a significant difference between all of the means compared to the control and with each other.

## THE GENETIC AND DEVELOPMENTAL ROLES OF DZIP1 ON MITRAL VALVE PROLAPSE

Paige Swanson

Governor's School for Science & Mathematics

Mentor: Russell Norris, Medical University of South Carolina

DZIP1 is a gene that is involved with producing cilia, long projections that aid in disease prevention. The genotypes of members of a large family where mitral valve prolapse is prevalent were examined, revealing that many of the affected family members had a mutation in this gene. Using a quick change point mutation protocol, DZIP1's interactions with other proteins were examined to determine if it caused a loss of function through protein instability. It was discovered that DZIP does interact with various ciliary proteins such as MECOM and CHIBBY in the centrioles of cilia.

## THE EFFECT OF VIDEO ANALYSIS ON INITIAL DISCUS LEARNING CURVE FOR NOVICE THROWERS

Noah Swingle

Chapin High School

The discus throw is an Olympic event in which a person hurls a weighted disc as far as they can. This event has been held since 776 BCE, but just in the last 100 years, throwers have adopted a new technique. Discus has been a sport largely unexplored by science and with today's technology, improvement can be made. This project aimed to shorten the initial learning curve of throwing discus by using video analysis. First, varsity level throwers recorded 30 throws and analysis of those videos revealed the individual needs of each thrower, with a focus on body angle, release angle, and foot separation. A group of beginner level throwers was assembled and divided into two groups: control and experimental. The control group received traditional coaching whereas the experimental group had access to video analysis and the optimal variables found earlier. The optimal variables found were leaning back, throwing flat, and having a wide stance. All beginner level throwers recorded a pre-coaching throw and three post-coaching throws which were averaged. A matched pair T test of the data from the two groups revealed a statistically significant improvement in their distances ( $p=0.004$ ), but no significance to the difference in coaching method ( $p=0.175$ ). This supports the idea that every thrower benefits from slightly different training, especially in the initial stages.

## CHARACTERIZATION OF PROXPA, HST, AND TPU FOR USE IN 3D PRINTING WITH SELECTIVE LASER SINTERING (SLS) MACHINES

Janelle Taliaferro

Governor's School for Science & Mathematics

Mentor: Jenny Reilly, 3D Systems

Selective Laser Sintering (SLS) is a form of 3D printing that uses thermoplastic semi-crystalline polymers in powder form. There are a variety of different powder materials that can be utilized in the SLS process, and each has different properties that can impact the 3D printing process in its own way. The purpose of this research was to determine if three specific powder materials – ProXPA, HST, and TPU – were suitable for use in SLS 3D printing and characterizing each of the materials to suit the SLS machines. Two tests were performed to determine if the powder materials could print a durable part: a differential scanning calorimetry test and a moisture analysis test. After receiving the results from the incoming tests, two more tests were conducted to help set the laser power, scan spacing, and layer thickness on the SLS machines to characterize ProXPA, HST, and TPU. These two tests included tensile testing and melt flows. The results verified that ProXPA, HST, and TPU can all produce durable parts through the SLS process. The results also verified that laser power, scan spacing, and layer thickness can successfully be set for each powder material to either maximize a part's resistance and strength, or minimize the print time. Through conducting this research, 3D Systems Corporation and its customers are now able to use three new powder materials in their printing process and alter any parts printed to their likings.

## EMERGENCY DEPARTMENT UTILIZATION BY DIABETIC PATIENTS IN SOUTH CAROLINA

Jonathon Tate

Governor's School for Science & Mathematics

Mentor: Christine Turley, Health Sciences South Carolina

The Centers for Disease and Control and Prevention (CDC) estimates that 9.3% of the U.S. population has Diabetes Mellitus. To best understand this disease's effect on hospital emergency department utilization, a retroactive analysis was conducted on South Carolina clinical data collected from 2007 to 2015. The data set consisted of 213,661 records, sourced from the Health Sciences Health Improvement Clinical Data Warehouse. Following the initial analyses, multivariate logistic regression was used to examine the association between patient characteristics and the odds of high ED utilization stratified by race. Results showed, regardless of race, patients under the age of 65 had a significantly higher risk of high emergency department (ED) utilization (4 or more visits). Chronic kidney disease significantly increased the risk of high ED utilization for African-American patients. Poor glycemic control significantly increased the risk of high ED utilization for White patients. Obesity significantly decreased the risk of high Emergency Department utilization for African-American patients.

## CORRELATION BETWEEN PERSONAL ORGANIZATION AND HIGH SCHOOL GRADE POINT AVERAGE

Sara Taylor  
Chapin High School

The average American spends one year of their life looking for misplaced or lost items. Many people struggle to find misplaced items because they are not organized in their home and/or workplace [7]. The visual cortex of the brain cannot process information or focus as much when there is clutter present [7]. The purpose of this project is to see if personal organization can affect the brain's ability to process information, making grade point average either increase or decrease. The study was conducted using fifty high school students from Chapin High School. The participants took a survey that included questions about their current grade point average and how organized they think they are. The questions that showed participants amount of organization were combined to create an organization score. The organization score showed how organized the person was. If the participant received a higher organization score, this meant that the particular participant was more organized than someone who received a lower organization score. The survey had diverse participants because it was given during MAST class, which is a class full of random students from each grade level. The data collected showed there was a negative 0.009 Pearson's Correlation R-value between personal organization and grade point average. Since the R-value was far from positive or negative one, for the majority of the participants, their organization did not affect their grade point average.

## THE IMPACT OF ARITHMETIC SKILLS ON THE ABILITY TO SOLVE SIMPLE ALGEBRAIC EQUATIONS

Caleb Taylor  
Chapin High School

A student's arithmetical abilities (multiplication, division, subtraction, addition) have been proven to significantly impact the strength of a math student. Observations prior to this experiment showed that Algebra 1 students struggle with the arithmetic portion of solving an equation. It has been studied that the most important aspect of mathematics for a student to learn and be successful in math class is number sense. Number sense can be defined as the understanding of the numerical patterns such as: number recognition, counting, quantity discrimination (magnitude), and basic number combinations, involved with doing mathematical calculations. The weakness of students in Algebra 1 called into question their arithmetic skills as a result of a failing grade in Algebra 1. This research used a written test of two sections, arithmetic and algebraic, to see what sort of correlation could be calculated between basic arithmetic and algebraic skills. The research shows is a correlation coefficient of 0.617, and a line of best fit-slope of 0.948, both showing a moderately strong connection in the data. The corresponding p-value is 0.0011, showing significance in the data.

## STUDY OF THE AGGREGATION OF AMYLOID-BETA 40 & 42 IN ALZHEIMER'S DISEASE

Dola Thota  
Governor's School for Science & Mathematics  
Mentor: Kumar Sambamurti, Medical University of South Carolina

In 1906, Dr. Alois Alzheimer's diagnosed Auguste Deter with a disease called Alzheimer's. The disease led to memory loss, dementia, loss of bodily functions, and, eventually, death. Auguste Deter became the first patient to have ever been diagnosed with Alzheimer's. It was not until the 1970s that Alzheimer's was considered a major cause of dementia. This led to a boom in research and the discovery of proteins Tau and Amyloid-Beta. Today, 5.4 million people in the United States are diagnosed with Alzheimer's. In the past century, only a little was discovered about Alzheimer's. We know that Alzheimer's is caused by the aggregation of proteins Amyloid-Beta and Tau around neurons but it is still unknown why they aggregate. This study focuses on the aggregation of Amyloid-Beta 40 and 42 under various conditions. The study was presented under the hypothesis that Amyloid-Beta aggregation is a multiphasic, multivariable, process. This was supported through studying different concentrations of Amyloid Beta 40 and 42 in multiple procedures that tested different incubation times, temperatures, concentrations, solvents, etc. The results from the procedures showed that there was a significant difference between the aggregation of AB 40 and 42. This seemed to show more successful results than ammonium hydroxide. Each procedure tested different antibodies at different concentration on the same sample. These results could then be used to test future ideas and questions about AB under cellular conditions.

## WATER FILTRATION SYSTEM

Bryan Tran  
Center for Advanced Technical Studies

Over time, the use of bodies of waters for recreational use is slowly contaminating the water with external pollution--such as discharged gasoline from water crafts. So, if a designed water system can purify water, then over time the water should be cleaner. To achieve this, a water system could be made with a filter to attached to it. The filter serves as a separator to split the water and fuel, and allow the clean water back into the body of water. Since not all the fuel can be separated at one time, the system must consistently run till all (or most) of the fuel is gone. Fuel measurements will be recorded every five minutes, and checked to see if the fuel has been separated from the water. The data collected during the proof of concept showed that a water filter system could be made, and that the water added to the system comes out of it as well. Even Though the data collected does not correlate with the hypothesis at this time, by adding gasoline to the water system to be filtered shows potential that it can be done. The water system filter could be placed at ramps and docks at lakes and large bodies of water.

This is to absorb and filter out the gasoline that is being leaked by boats and water crafts. Later on, more arguments could be made to the system, by adding a fine mesh layer on top to catch debris on the water.  
Fuel Separator

THE EFFECTIVENESS OF WORKSTATION ORGANIZATION OF MEDICAL ERRORS IN THE OPERATING ROOM  
Stewart Trask

Governor's School for Science & Mathematics  
Mentor: Kenneth Catchpole, Medical University of South Carolina

Throughout the world, medical errors have become increasingly prevalent and, over the years, have been the cause of numerous deaths within hospitals. More recently, researchers have been looking into specific ways to reduce these errors, especially in the anesthesiology department, since drug errors account for such a large number of these medical errors. This research studied using an organized tray in the operating room to reduce drug swaps. This tray would organize all syringes for a given surgery and was disposable to avoid contamination. We interviewed CRNAs and Residents in order to see what aspects of the tray are important in order to create a modified product with enough slots and durability for proper functionality.

ASSESSING THE ADSORPTION CAPACITIES OF HYPERACCUMULATOR BIOCHARS COMPARED TO WOOD WASTE BIOCHAR

Kristina Trifonova  
Spring Valley High School

Current heavy metal removal methods are expensive and impractical, so finding an alternative method is vital. Biochars are natural heavy metal adsorbents, but are often ineffective, having low adsorption capacities. This experiment aimed to find a cost-efficient method of increasing biochars' adsorption capacities and hypothesized that biochars made of hyperaccumulator plants, which are able to remediate heavy metals in soil, would perform better than wood biochar. Biochars were made of three hyperaccumulator plants, *Helianthus annuus*, *Beta vulgaris* cicla, and *Brassica oleracea* var. *sabellica*, and wooden planks on a gas grill at 315°C. A 50 mg/L solution of methylene blue (MB), a cationic dye which mimics heavy metals, was made and 2g/L of biochar was added. Its absorbance was measured at 670 nm before and after treatment using a spectrophotometer. The solution was periodically stirred over 24 hours after which the amount of methylene blue was found and used in the equation  $q = (C_0 - C_e) / V * M$  to calculate the biochar's adsorption capacities. Kale biochar had the highest adsorption capacity (21.58 mg MB/g biochar), followed by sunflower (21.00 mg MB/g biochar), chard (19.54 mg MB/g biochar), and wood (0.94 mg MB/g).

EFFECT OF LAKE DEPTH ON BIOELECTRICAL POTENTIAL OF SEDIMENTS IN MICROBIAL FUEL CELLS

Ryan Trinter  
Chapin High School

The need for clean, renewable energy is growing exponentially as the world is slowly moving towards the end of the present fossil fuels. Less developed countries are entering periods where industrial fuels, such as oil and coal, are becoming increasingly necessary. Evidence suggests that clean energy lies in four main sources: wind, solar, nuclear and biomass. This project explores potential behind biomass and answers the question: "What is the potential for the biological production of electricity from sediment in Lake Murray?" Measuring the output of microbial fuel cells developed with sediments from different depths of Lake Murray, bacterial diversity, affected by depth, caused different levels of electrical production. Using a multimeter, the voltage and current between a biological oxidation anode and a reduction cathode was measured. Experimentation showed that depth was a statistically significant factor that affected electrical output of Microbial Fuel Cells (MFC). An MFC made with common materials produced low voltages, between 5mV-90mV, and a nonexistent current. The lack of current was due to the high internal resistance from microbial fuel cells established with a salt bridge. Although the power output was very low, making large scale reliance on microbial fuel cells for energy unfeasible in this case, similar research also suggests that microbial fuel cells with higher quality materials have potential to achieve larger notoriety [Pant, Singh, Van Bogaert, Olsen, Nigam, et al. 2012].

FLUORESCENT LABELING TO GENERATE GREEN FLUORESCENT PROTEIN (GFP) POSITIVE NEURAL STEM CELLS

Chase Turner  
Governor's School for Science & Mathematics  
Mentor: Ana Martin-Villalba, German Cancer Research Center

Neural stem cells (NSC's) often follow the same path of migration throughout the brain, traveling from the ventricles to the olfactory bulbs via the rostral migratory stream. However, they sometimes shift their migration to the striatum for an unknown reason during ischemia. The goal of this research is to develop a new method of labeling NSC's with green fluorescent protein (GFP) in order to create a large source of accessible cells that could be used to visually record the patterns in the shift of migration. The episomal DNA injected into the mice created with EF1 $\alpha$ , CMV, and UBC promoters, GFP, and a kanamycin resistance gene. This episomal DNA was then injected into mice at varying concentration of DNA and PEI (branched-polyethyleneimine). The mice rested for three days, and the 15  $\mu$ m left-ventricular samples were stained using

immunofluorescence. The NSC's with the highest expression of GFP were found with the CMV promoter, but the quantity was not enough to create a stable cell line. The same experiment was run for a 7-day incubation period; however, resulted in no successfully transfected cells. It was hypothesized that this may be due to the PEI toxicity after extended periods. An in-vitro transfection with the EF1 $\alpha$ , CMV, and UBC promoters and nucleofection was performed over three weeks. A FACS analysis showed that the EF1 $\alpha$  promoter NSCs generated a large viable pool of cells and could potentially become a new method to create GFP-labeled cells with further trials and testing.

#### THE EFFECTS OF ETHANOL CONCENTRATION ON CONTACT ANGLE

Nathan Ulmer

Governor's School for Science & Mathematics

Mentor: Chen Li, University of South Carolina Columbia

Heat pipes are used to transfer heat away from a heat source in a variety of applications such as on the International Space Station and in personal computers. Binary fluids, or solutions of two fluids, have been shown to increase the efficiency of heat pipes. The purpose of this study was to determine the effects of a binary fluid on contact angle. This will aid in the development of more efficient heat pipes. In this case, ethanol and water were used as a binary fluid. The contact angle is the angle at which a droplet contacts a surface. To determine the contact angles of the chosen binary fluid, two silicon surfaces were devised: one hydrophilic, the other hydrophobic. The contact angles of droplets of different concentrations were measured on these surfaces using a device called a goniometer, and this data was analyzed. The hydrophobic surface produced the expected result, which was a linearly decreasing contact angle. The hydrophilic surface, however produced a somewhat unexpected result, and did not have a decreasing contact angle with the increasing concentration of ethanol. These results will allow researchers in the field of heat and mass transfer to further investigate the use of binary fluids in heat pipes.

#### THE USE OF CANCER MICRO-TUMORS FOR ANTI-CANCER DRUG SCREENING

Nikhil Vallabhaneni

Governor's School for Science & Mathematics

Mentor: Jorge Rodríguez-Dévora, Clemson University

The dosage of a drug that doctors administer to cancer patients can be very dubious. In a real-world scenario, if the patient is young, then they will give them a stronger dosage and if the patient is older, the doctor will give them a weaker dosage. The doctor can also perform a biopsy of the cancer, but the cancer cells quickly de-differentiate in extracorporeal environments, and this uncertainty can obviously be problematic. Therefore, the purpose of this experiment was to test if cancer micro-tumors could be cultured and if drugs can be screened on these cells. Micro-tumors are a conglomerate of cells. Micro-tumors can be vital to drug screening because they do not dedifferentiate in an extracorporeal environment. The drug that was used was doxorubicin which is a common anti-cancer drug. Then T98G cells were grown, and the cells were tested in different dosages of doxorubicin. The end goal was to see whether increased dosage of doxorubicin would decrease the volume of T98G spheroid micro-tumors. If doxorubicin was tested on cancer-cell spheroids, then higher doses of doxorubicin should cause higher degeneration in the cancer cell. In the end, the expected logarithmic decrease in cancer size as dosage increased was not seen. Even though the expected results were not found, the micro-tumors still have a net decrease in size which is positive for the development of micro-tumor drug screening.

#### AN ACUTE TOXICITY TEST ON THE EFFECT OF VARYING CONCENTRATIONS OF TITANIUM DIOXIDE NANOPARTICLES ON *DAPHNIA MAGNA* AND *ARTEMIA SALINA*

Sreeja Varanasi

Spring Valley High School

Due to tremendous advancements in the field of industrial and consumer products, nanomaterials are being increasingly produced all over the world today. This future multi-trillion dollar business has made some concerned about nanoparticles polluting freshwater and marine regions specifically. A new research field called "aquatic nanotoxicology" explores the impacts of nanoparticles on aquatic organisms and their ecosystems. This field has become more widely studied due to the fact that 0.4-7% of all engineered nanoparticles reach a water body. The purpose of this experiment is to evaluate the effects of titanium dioxide (TiO<sub>2</sub>) nanoparticles on *Daphnia magna*, a freshwater organism, and *Artemia salina*, a marine organism. It was hypothesized that if different concentrations of TiO<sub>2</sub> nanoparticles are exposed to *Daphnia magna* and *Artemia salina*, then higher concentrations will cause more toxic effects to the organisms because some nanomaterials have been proven to be toxic to aquatic life. Aqueous concentrations of 1, 10, and 50 mg/L of TiO<sub>2</sub> nanoparticles were prepared and exposed to ten organisms of *Daphnia magna* and *Artemia salina* for 96 hours. The mortality rate was checked daily. A linear regression test of R<sup>2</sup> = 0.278, p = 0.4726 for the mortality rate of *Daphnia magna* showed that increased concentrations of TiO<sub>2</sub> nanoparticles did not have an increased impact on the freshwater organisms. Similarly, a linear regression test (R<sup>2</sup> = 0.489, p = 0.3008) was run for *Artemia salina*, and it indicated that increased TiO<sub>2</sub> nanoparticle concentrations did not have an impact on the marine organisms either. In conclusion, the increased concentrations of TiO<sub>2</sub> nanoparticles had no increased impact on either organism.

## THE EFFECT OF COPPER (II) SULFATE AND IRON (II) SULFATE ON GAS PRODUCTION, ABSORBANCE, AND PH OF *CHLAMYDOMONAS REINHARDTII*

Sreya Varanasi  
Spring Valley High School

Today's society requires copious amounts of energy to support millions of technology oriented lives. Hydrogen, a clean and inexpensive fuel, has piqued the interest of scientists, but it is often produced with environmentally harmful fossil fuels. A renewable alternative is the inefficient algae *Chlamydomonas reinhardtii*, which produces hydrogen through photosynthesis. This research was aimed at comparing the hydrogen -producing capabilities of *C. reinhardtii* cultures when enhanced with copper and iron. It was hypothesized that the addition of iron (II) sulfate would produce a higher amount of gas, a greater change in absorbance, and a lower pH. Absorbance (nm) was taken before the 20 mg/L of iron (II) sulfate and 0.8 mg/L of copper (II) sulfate solutions were added, and pH was taken afterwards. After 20 days, pH, absorbance, and gas (mL) produced were recorded. An ANOVA determined the values were insignificant for gas production, as  $p > \alpha$  ( $F(2, 25) = 0.07$ ,  $p = 0.9290$ ), showing that neither the copper nor the iron treatment had significant effects. For pH,  $p < \alpha$  ( $F(2, 27) = 13.50$ ,  $p < 0.001$ ), indicating significance. A Tukey test determined the copper and iron treatments were significantly different from the control, but not from each other. Absorbance values were insignificant, as  $p > \alpha$  ( $F(2, 27) = 0.52$ ,  $p = 0.6031$ ), leading to a similar conclusion as the gas production test. The hypothesis that adding iron would increase H<sub>2</sub> production was not supported because two of the three tests yielded insignificant data.

## DIESEL EMISSIONS

Isaac Vardi  
Center for Advanced Technical Studies

Diesel engines are infamously known for dirty emissions, so how can diesel emissions potentially be cleaner? If a cleaner burning diesel fuel is utilized in a diesel engine, then the resulting particulate emissions will be significantly lower. In this study multiple experiments will be performed to identify the cleanest burning diesel fuel and/or mixture available. Renewable bio-diesel was first synthesized using waste cooking oil and tested to ensure fuel quality standards. The first testing phase of the project involved burning 100% petroleum diesel, 100% biodiesel, and various bio-petrol diesel blends in a lantern surrounded by a chimney and then accounting for the particulate residue that formed on the chimney surface after a one hour trial period. Results to date show that pure petrol diesel shows significantly more particulate residue for each trial when compared to results for pure bio-diesel. In addition, blended diesel fuels with lower bio-diesel amounts also show significantly more particulate residue than blends with higher bio-diesel amounts. In conclusion, if a cleaner burning diesel fuel is used then less harmful particulate emissions will result. Using bio-diesel in a diesel engine reduces more than half of the particulate emissions when compared to pure petrol diesel fuel. In future trials, additional emissions tests will be employed as well as investigating a wide array of bio-petrol diesel blends for commercial application.

## THE ROLE OF ALDEHYDE DEHYDROGENASE 2 IN LIVER ISCHEMIA/REPERFUSION INJURY

Eric Vo  
Governor's School for Science & Mathematics  
Mentor: Zhi Zhong, Medical University of South Carolina

Aldehyde Dehydrogenase Activator-1 (Alda-1) is an agonist that increases the production of the enzyme Aldehyde Dehydrogenase-2 (ALDH-2). Studies have shown that ALDH-2 is helpful in degrading harmful aldehydes. With knowing this, it has become a drug of interest in liver related drug research. If ALDH-2 plays an important role in prevention of hepatic ischemia/reperfusion injury, ALDH-2 deficiency should exacerbate ischemia and activation of ALDH-2 should attenuate ischemia/reperfusion injury. The aim of this research was to determine whether ischemia/reperfusion injury increased in the ALDH-2 deficient mice and also to confirm that Alda-1 has protective effects against ischemia/reperfusion injury. In our investigation, we wanted to determine if the Alda-1's activation of ALDH-2 was causing the desired effect (to protect the liver) and not an off target effect of introducing the Alda-1. This was done by analyzing the livers of five mice: Control, Wild Type, ALDH-2 Knock Out (KO), Vehicle, and Alda-1. The ALDH-2 KO and Wild Type underwent ischemia for thirty minutes and reperused. The Vehicle and the Alda-1 underwent ischemia for one hour and reperused. After reperfusion the liver samples were collected six hours after the process was performed. We measured the amount of alanine transaminase (ALT), cleaved caspase 3 (CC3), Myeloperoxidase (MPO), and F4/80 through western blotting. We also investigated the histology of the cells. All of our data confirmed that ALDH-2 does have protective effects against liver ischemia/reperfusion injury. In future studies statistical analysis and a larger sample size is needed to confirm these findings.

## IS DEPRESSION RELATED TO HEALTH-RISK BEHAVIORS AMONG ADOLESCENTS?

Vivian Vork  
Governor's School for Science & Mathematics  
Mentor: Kate Flory, University of South Carolina Columbia

A number of children tend to have emotional or behavioral disorders of which their parents are unaware. Many children, who have been diagnosed with emotional or behavioral disorders, are not receiving the correct help, or any help, they need in order to get better. The USC Project to Learn about Youth has conducted research on a diverse school district within South Carolina to estimate how many adolescents in grades K-12 have some of these health concerns. A more focused goal was to

see if there was an association between elevated depression and health-risk behaviors among these adolescents. The Youth Risk Behavior Survey (YRBS) and the Revised Child Anxiety and Depression Scale Survey (RCADS), were used to monitor risky behaviors in which students had taken part and depressive symptoms that the students were experiencing, respectively. The answers to the questions were dichotomized from 0-2 points; 0 being a not risky answer and 2 being the riskiest answer. With the use of two of these self-reported surveys from the children in grades 4-12 and a complex data system, a direct relationship was found between elevated depression and texting while driving as well as between elevated depression and alcohol use. Although there was some association found, the results should be viewed with caution, as the sample size was significantly smaller than hoped for and there was no indication telling whether or not the children drank because they were depressed, or were depressed because they drank.

#### THE EFFECT OF HISTONE METHYLATION ON NOISE INDUCED HEARING LOSS

Delaney Walden

Governor's School for Science & Mathematics

Mentor: Su-Hua Sha, Medical University of South Carolina

The mechanism for noise induced hearing loss is currently unknown thus, it is not known how to prevent or treat it. Mice treated with BIX-01294, a pharmacological inhibitor, were compared with control mice after both groups were exposed to damaging levels of noise. The differences in outer hair cell damage and hearing loss were evaluated. The mice treated with BIX-01294, which inhibits histone methylation, exhibited less methylation than the control mice, indicating that the inhibitor worked as predicted. The BIX-01294 treated mice also exhibited fewer signs of noise induced hearing loss and had significantly less outer hair cell loss. This suggests that the inhibition of methylation could be used as a method to prevent noise induced hearing loss.

#### THE DEVELOPMENT OF A PHOTON-BASED VELOCIMETER TO STUDY TRANSPORT PHENOMENA OF TUMOR CELLS

Audrey Wang

Dutch Fork High School

Mentor: Guiren Wang, University of South Carolina Columbia

Cancer research has thus far been largely confined to focus on molecular biology, specifically gene alterations within tumor cells, but researchers have recently adopted a new way of approaching this phenomenon: studying the role of fluid dynamics. Knowledge on blood flow dynamics, especially shear stress, is essential for understanding the growth, progression, and metastasis of cancer, commonly known as malignant cancer. Understanding the transport phenomena of circulating tumor cells and biomarkers in blood flow is crucial to greater understanding of the pathology of tumors in extravasation, which is the penetration of the blood vessel membrane by tumor cells as they leave, as well as optimizing pharmacology of future cancer treatment drugs, based on how drugs operate under certain flow velocity conditions. Blood flows at different velocities at different radial positions in a microcapillary tube, just as water does. However, the exact velocity profile of blood through a microcapillary is unknown. Currently, there are several methods of velocimetry on the micro-scale, but they cannot measure on such a small scale since the resolution is too weak. Current methods of velocimetry mostly use micro- and nano-particles as tracers (such as blood cells). However, this significantly reduces spatial resolution, so they cannot measure velocity profile within a blood capillary. Therefore, a velocimeter that can measure velocity profile in blood capillaries is needed.

#### DOES A HANDS-ON, VISUAL PRESENTATION ABOUT WILDLIFE TO ELEMENTARY STUDENTS IMPACT LOCAL AWARENESS ABOUT WILDLIFE RESCUE?

Karsen Ward

Chapin High School

Wildlife rescue centers take in injured or abandoned wild animals with the goal of rehabilitating them to be released back into their natural environment [Rescue Advice, 2016]. The public lacks general knowledge about how and when to intervene in the lives of wild animals, which has a negative impact on both wildlife and the rescue centers themselves (Help! I've Found an Animal, 2016) (Seacrist, September 7, 2016). This study specifically investigates how a hands-on, visual presentation about wildlife to elementary students impacts local awareness about wildlife rescue. Students ages 6 to 8 at Harbison West Elementary School were tested for their knowledge about wildlife behavior and rescue before and after a hands-on educational presentation was given in partnership with the Carolina Wildlife Center. The same pre and post surveys were given to their parents, who were not present for the program, in anticipation of the students possibly sharing the new information. It is important for awareness of these topics to spread so that wild animals are not unnecessarily separated from their habitat or mother, their survival instincts aren't altered, and the resources of wildlife rescue centers are saved for the animals who truly need help. Results indicate that elementary education is an effective method for increasing overall local awareness about wildlife behavior and rescue, most significantly among students and to a less significant extent among parents.

## THE PREVALENCE OF EMOTIONAL AND BEHAVIORAL DISORDERS IN YOUTH

Samantha Wei

Dutch Fork High School

Mentor: Dr. Kate Flory and Katelynn Burgess, University of South Carolina Columbia

Emotional and behavioral disorders in school-aged children are associated with social difficulties and risks such as school dropout, substance-related disorders, and suicide/homicide. It is important to understand the mental health disorders of youth for identification, prevention, and treatment. This research project is determining the prevalence of internalizing, externalizing, and tic disorders in students from elementary to high school ages in a rural South Carolina school district. Some examples of these disorders are ADHD, suicidal thoughts, anxiety, and depression. Teachers complete a screening of their class and students and their families are invited to participate in an in depth, one-on-one screening with a clinician. Students who participate in the study are able to receive a free evaluation and be referred to resources in their community. The purpose of this research is to identify the rates of occurrence of disorders, describe mental health treatments with children already diagnosed with mental health issues, and assess the misuse of medications prescribed for treatments of disorders.

## SLEEP LOSS AND MOTOR VEHICLE CRASH CORRELATION SURVEY IN ADOLESCENTS

Beverly Whitesides

Chapin High School

Motor vehicle accidents are the fourth leading cause of death in the United States, with more than half of 1.3 annual deaths being young adults aged 15 to 44. Teens aged between 14 and 17 years old are recommended to get between 8 and 10 hours of sleep every night, but due to schoolwork, practices, and other commitments many teens do not get enough sleep, leaving them sleep deprived. Getting less than the recommended 8 to 10 hours of sleep can cause symptoms such as drowsiness, slower reaction times, an increase in the stress hormone cortisol, moodiness, impaired memory, lack of ability to process information, and a greater risk of being involved in a motor vehicle accident. Teens at Chapin High School from randomized MAST classes are asked to take an anonymous survey taking into account what would cause them to lose sleep, their type of license, and if they have been in a motor vehicle accident where they were the driver, if so they then rate the crash, and state how much sleep they received the night before. A correlation between the hours of sleep they received the night before and their crash is seen, proving teens are sleep deprived and are posing a greater risk on the roads.

## IDENTIFYING REGIONS OF THE CXCR3 PROMOTOR REQUIRED FOR ACTIVATION BY FLI1 IN STIMULATED T-CELLS

Winter Widdifield

Governor's School for Science & Mathematics

Mentor: Tamara Nowling, Medical University of South Carolina

Lupus is an autoimmune disease that causes inflammation of tissues in several important body systems, including the kidney. FLI1 is a transcription factor that regulates hematopoiesis, hemostasis, cell death, and cell cycle. FLI1 regulates CXCR3 expression. CXCR3 is a receptor in the kidney that is key to T-Cell migration to the kidney, and is upregulated by FLI1. It was found previously that reducing levels of FLI1 decreases T-Cell CXCR3 expression in lupus mice. In our lab we focused on lupus nephritis (kidney inflammation) and how we could lessen the upregulation of hCXCR3 to possibly lessen the effects of lupus in the future. In our study we sought to identify the region of the hCXCR3 promoter that is required for activation by FLI1 in stimulated T-cells. We transfected deletion sequences of hCXCR3 and FLI1 into jurkat T-cells. Then we performed a luciferase assay on the transfection to measure the luminescence expression of hCXCR3. We found that the nucleotides between -89 and +200 are important for the upregulation of hCXCR3. Then we tested FLI1 mutants to see how they affected the expression of hCXCR3. The FLI1 DNA binding mutant caused a decrease in expression, and the acetylation and phosphorylation mutant caused an increase in the hCXCR3 expression. From this we can conclude that the region between -89 and +200 includes a key binding site for FLI1 to bind to hCXCR3.

## THE EFFECTS OF GLYPHOSATE VERSUS SPINOSAD ON THE NITRATE CONCENTRATION IN THE SOIL

Mikaila Widener

Spring Valley High School

Glyphosate is the most common chemical herbicide used in the United States. However, chemical pesticides can prevent the growth of the nitrogen-fixing rendering the soil of its capability to grow plants efficiently. This study aimed to find a possible alternative for chemical pesticides. It was hypothesized that glyphosate would cause the largest decrease in the nitrate concentrations. The two types of pesticides used were glyphosate and spinosad. 5 mL of the glyphosate and the spinosad were applied to the assigned soil samples. The control was given 5 mL water. This took place every other day for 5 days. The nitrate concentrations were evaluated on the seventh day of the experiment. The glyphosate did cause the largest decrease in the nitrate concentration with a mean concentration of 2.714 ppm, spinosad having a mean concentration of 3.857 ppm, and the control with a mean concentration of 9.524 ppm. An ANOVA ( $F(5,120) = 238.89, p < 0.001 < \alpha = 0.05$ ) showed that there was a significant difference between the before and after for the glyphosate and the spinosad and there was a statistically difference between the after data for the control, glyphosate, and spinosad. These results indicate that an organic pesticides (spinosad) could be a plausible alternative for chemical pesticides (glyphosate).

THE EFFECT OF DIFFERENT KINDS AND AMOUNT OF GRANULAR MATERIAL ON THE STABILITY OF A BALL  
ROLLING DOWN AN INCLINED RAMP.

Bangjie Xue  
Heathwood Hall

This experiment determined the relationship between different volume of granular material filled in a one eighth increment of the diameter and the minimum start angle of a ball on an inclined ramp. The result suggests that there is a relationship between different volume of granular material and the starting angle of the ball. The angle that required to start the ball from rest increased as the material inside decreased. However, when the granular material reached a minimum point, the angle decreased largely. The independent variable was the amount and types of granular materials inside the ball, and the dependent variable was the minimum angle required to start the ball from rest. The result of this study can help determine the stability of a non-filled container.

CHARACTERIZATION OF THE INTERACTION BETWEEN SECRETED FRIZZLED-RELATED PROTEIN 2 (SFRP2) AND  
FRIZZLED-5 (FZD5) BY CO-IMMUNOPRECIPITATION

Vincent Ylagan  
Governor's School for Science & Mathematics  
Mentor: Nancy Demore, Medical University of South Carolina

Cancer is the second most common cause of death in the United States and affects approximately 39.6 percent of men and women. Angiogenesis, the creation of blood vessels, is a key element in the growth of cancerous tumors since blood vessels supply the nutrients and oxygen that tumors need to grow. Current forms of therapy that target angiogenesis are not always effective at eliminating tumors, so new forms of treatment that affect angiogenesis must be developed. Secreted Frizzled-Related Protein 2 (SFRP2) and Frizzled-5 (FZD5) are two proteins that show promise as cancer treatments. Both SFRP2 and FZD5 are associated with angiogenesis, cancer growth, and the Wnt signaling pathway, which controls cellular processes such as cell migration and the development of organs in embryos. Verifying that a relationship exists between the two proteins would clarify how they work together to promote tumor growth. We performed a co-immunoprecipitation to determine whether FZD5 binds to SFRP2 by isolating SFRP2 with FZD5 bound to it from a 2H11 cell lysate using magnetic beads coated with anti-SFRP2 antibody. A series of Western blots confirmed that SFRP2 and FZD5 are expressed in the cell lysate and that FZD5 binds to SFRP2, which shows that FZD5 is the receptor of SFRP2. Eventually, therapies that target this interaction could inhibit angiogenesis and the related tumor growth.

THE EFFECTS OF SPECIFIC BACKGROUND VARIABLES ON THE AGGRESSION OF ADOLESCENTS PLAYING  
TETRIS

Zachary Young  
Spring Valley High School

Video games have been known to cause aggression in adolescents due to a variety of factors. The purpose of this experiment was to measure the effects of competitiveness, previous exposure, perceived personal performance, and actual performance on aggression in adolescents, and to measure the correlations between those variables. The hypotheses were that the participants who played Tetris would have a lower aggression score than those who did not, and that there would be a positive correlation between how long someone has been playing video games and their aggression score. A group of 48 randomly selected adolescents were assigned to play the game Tetris or not. The participants who played the game completed a survey beforehand and then completed the Buss and Perry Aggression Questionnaire after playing. The participants who were not assigned to play answered the Aggression Questionnaire without filling out the survey. A t-test showed that the effect of playing Tetris was not significant on aggression,  $t(19) = -0.176$ ,  $p = .43$ ,  $\alpha = 0.05$ . A later correlation test showed four significant correlations between frequency, starting time, perceived skill, and competitiveness. Starting to play video games earlier in life led to strong positive correlations with how often one plays them. Furthermore, participants who have played video games for longer and play more frequently tended to think more highly of their own skill than participants who have played for less of their lives and play less frequently. Lastly, a moderate, positive correlation was found between competitiveness and confidence in playing ability.

USING AN EYE TRACKER TO DETERMINE WHETHER INSTRUCTIONS ARE UNDERSTOOD BY THE USER

Victoria Young  
Governor's School for Science & Mathematics  
Mentor: Peter Hevesi, German Research Center For Artificial Intelligence

In the past few years, research done with eye trackers has increased tremendously. Though this research spans many fields, it has failed to reach into one area – comprehension of instructions. Our research used eye tracking techniques to identify difficult steps and lack of comprehension in seven subjects. Fixations are defined as points between saccades, or the time when the eye is still while focusing or looking at something. Fixations can be separated into two categories. Voluntary fixations are longer fixations that occur by the subject's will. Involuntary fixations are short fixations that occur naturally or unwillingly. Using the rate of voluntary fixations of a subject, it is possible to determine the most difficult portions of written instructions and diagrams for a given task. This research identified the correlation between voluntary fixations, complexity,

repetition, and comprehension of instructions. In the future, this research could be developed into an app or tool which teachers and students alike could use to identify problem areas and recognize difficulty in learning.

#### DETERMING THE COMPLEXITY OF A PROGRAM TO AID PROGRAMMING

Andrew Zheng

Governor's School for Science & Mathematics

Mentor: Brian Malloy, Clemson University

Computing is a growing industry. Teaching coding to beginning programmers has focused mainly on the introduction of a language and writing correct code. Little attention has been given to strategies for writing highly efficient code. Clemson University, in hopes of helping their students learn to program, has created a prototype server that uses two metrics to quantify the efficiency of a programmer's code. The quantified values display the complexity of a source code, which in turn determines the code's quality. In this paper we discuss a third metric to further define the efficiency of a code. Using a heuristic, we were able to calculate a suitable value for the order of complexity (big-O), of any source code based on its execution time. This algorithm will be added to the prototype server and provide additional information for Clemson students as they learn how to program.

#### DIET AND DEPRESSION: A STATICAL ANALYSIS OF MAGNESIUM INTAKE AND DEPRESSIVE SYMPTOMS

Dabriel Zimmerman

Governor's School for Science & Mathematics

Mentor: Bernadette Marriott, Medical University of South Carolina

The Better Resiliency among Veterans and Non-Veterans with Omega-3 fatty acids (BRAVO) study evaluated the effectiveness of using omega-3 fatty acids to reduce negative emotions and suicidal ideation. In this study, participants went through a monthly array of tests to analyze emotional state and nutritional intake. This sub-study focused on two preliminary tests, one that analyzed severity of depressive symptoms and another that analyzed nutritional content in terms of Magnesium intake. Participants were grouped by those who did not meet their estimated average requirement of daily Magnesium intake versus those who did meet the requirement from data taken from the nutritional tests; in addition to grouping them from normal to extreme depression based off of data taken from the depressive symptoms test. Statistical analysis tests were performed to determine if there was a positive inverse relationship between Magnesium intake and depressive symptoms. The linear correlation coefficient was 0.06 and the p value from a Chi-Square analysis was 0.53, indicating that there was no relationship found between preliminary data taken from both tests.

END

SC Junior Academy of Science Abstracts