

# VIRGINIA JUNIOR ACADEMY OF SCIENCE PROCEEDINGS

78TH ANNUAL MEETING & RESEARCH SYMPOSIUM OLD DOMINION  
UNIVERSITY NORFOLK, VIRGINIA MAY 23, 2019

## Animal and Human Sciences

### Salt Affecting Brine Shrimp

*Tucker Albaugh and Felix Green, Mary Ellen Henderson Middle School*

Our experiment that we were testing is how does the concentration of salt in water affect how many brine shrimp's eggs hatch and live for a day. We had 4 different independent variables. They were 3.5%, 2%, 5% and 6%. The purpose of this experiment was to find how the rising salt levels of the ocean will affect brine shrimp and its population. We measured how many brine shrimps survived by taking them out of the hatchery and hand counting. We conducted the experiment by weighing the water and then weighing the salt to find the salinity. In the first 3 levels of salt the number of Brine Shrimp increased but when the shrimps were placed in 6% salinity they decreased. Something that we realized from studying our graphs was that our data was not scattered. Another thing we realized was that in trial 4 the 5% salinity the most amount of shrimp hatched (with 69.3% hatched). We also realized that the 2% (which had a hatch rate of 65%) and the 3.5% (which had a hatch rate of 66.4%) the number of shrimps that hatched in the 4 trials were very similar. Our data supported our hypothesis was supported until we reached 6% salt (only 61% hatched). Our experiment can relate to the information we already knew because brine Shrimp are exceptionally tolerant to high levels of salt in the water.

### The Effect of Different Types of Antioxidants Against Hydrogen peroxide on the Heart Rate of *Daphnia magna*.

*Nikhil Amin, George H. Moody Middle School*

The U.S. National Library of Medicine published an article outlining the essential role of antioxidants in the health of the human body. Through data that determined antioxidants as questionable in effectiveness for the treatment of diseases, the study of antioxidants' counter effect on oxidants arose by comparing the human body to *Daphnia Magna*. The purpose of this experiment was to test different types of antioxidants by being able to counter the negative effects of hydrogen peroxide through testing the heart rate change of *Daphnia Magna*. The different types of variables being tested were garlic, ginger, turmeric, cranberries, and no antioxidants. Samples of *Daphnia* were placed in 150 mL beakers filled with 100 mL of water and were treated regularly every other day for twenty days. The heart rate of each *Daphnia* was tested before and after the application of 0.1 mL of hydrogen peroxide into the beaker. Next, a different antioxidant was placed into each beaker and was measured to test which allowed the *Daphnia*'s heart rate to decrease the most efficiently. The results indicated that turmeric was able to sustain the heart rate of the *Daphnia* the most effectively at 210 beats per minute. The data supported the research hypothesis that if turmeric was applied to *Daphnia Magna*, then it will be able

to counter the effects of hydrogen peroxide the best. Based on the research data, there appears to be a direct correlation between the anti-inflammatory effects of curcumin, the powerful antioxidant ingredient of turmeric, and the heart rate change of *Daphnia*. However, before the data can be concluded that curcumin was the reason for turmeric's positive counter effects, further studies will need to be conducted using various quantities of curcumin.

### **The Effect of Different Antacids on the Rate of Neutralization**

*Shreyas Arcot, George H. Moody Middle School*

### **The Effect of Sound on Ants**

*Guthrie Bowers, Sabot at Stony Point*

This experiment was designed to gather knowledge about whether or not ants change their behavior due to different levels of sound. The problem is that ants invade a house and the owner's personal space. Various sound waves were tested to show how ants would react when subjected to sound. Two different characteristics of sound were tested, volume and frequency. The data shows that different sound waves do change the ants' behavior from moving regularly to not moving, and from not gathering to gathering. Test results generally indicated that increases in volume and frequency resulted in less movement. Increases in volume and frequency were not as consistent in gathering, but a general trend of more gathering was measured.

### **The Effect of Grooming on the Heart Rate of *Equus caballus***

*Stella Brakman, Sabot at Stony Point*

This experiment was designed to gather knowledge about whether or not ants change their behavior due to different levels of sound. The problem is that ants invade a house and the owner's personal space. Various sound waves were tested to show how ants would react when subjected to sound. Two different characteristics of sound were tested, volume and frequency. The data shows that different sound waves do change the ants' behavior from moving regularly to not moving, and from not gathering to gathering. Test results generally indicated that increases in volume and frequency resulted in less movement. Increases in volume and frequency were not as consistent in gathering, but a general trend of more gathering was measured.

### **To Breathe or Not to Breathe: Can Face Masks Diminish Inhaled Pollution and Improve Health Outcomes in *Drosophila melanogaster*?**

*Tony Bright, Arman Lateef and Gabriel Ralston, Louise Benton Middle School*

Main Objectives: Air pollution is a serious, global problem that threatens all living organisms. The objective of this project was to determine whether face masks can significantly diminish inhaled particulate matter (PM) less than 2.5 microns in diameter (PM 2.5) and improve health outcomes in *Drosophila melanogaster* (fruit fly). It was hypothesized that if *Drosophila* is exposed to high levels of PM 2.5 then its lifespan and fertility will decrease. Also, if a Vogmask is used, then it will significantly decrease the amount of inhaled PM and mitigate the impact of PM 2.5 on longevity and fertility, compared with a doctor's mask or no mask. Methods: Flies were exposed to pollution in a controlled chamber using the exhaust from a gas-powered STIHL Echo-One trimmer.

An air pollution monitor was used to record PM 2.5 levels. Mask Efficacy - Exhaust was run through a tube (uncovered or covered with either a doctor's mask or Vogmask) and the transmitted PM 2.5 was recorded. Longevity and Fertility— *Drosophila* were placed into 4 experimental groups: 1) No pollution; 2) Pollution and no mask; 3) Pollution and vials covered with doctor's mask; 4) Pollution and vials covered with Vogmask. After 6 hours of pollution exposure, flies in groups 2, 3, and 4 were transferred to an incubator, with unexposed flies, and their lifespan was monitored. To assess fertility, 3 male and 3 female flies were placed into each vial and pupae were counted on day 5. Results: The doctor's mask and Vogmask decreased inhaled PM 2.5 by 71% and 92% respectively. Pollution decreased *Drosophila* lifespan by 80% whereas pollution exposure while wearing a Vogmask decreased lifespan by 53%. The control group had significantly more mean offspring (4) than either the Vogmask (1.5), the doctor's mask (0.5) or no mask (0.25). Conclusions: Face masks can be quite effective at filtering out particulate pollution; however, they are not the ultimate answer to our environmental emergency. We must remain committed to cleaning up our planet in the first place.

### **Iron versus Speed**

*Claire Buchholz and Abbey Shumsky, Swanson Middle School*

The purpose of this experiment was to find the effect of the brand of multivitamin on the dissolution time and the iron content. The independent variable was the brand of the multivitamin, and the dependent variables were the dissolution time and the iron content. 5 multivitamin brands were tested and Nature Made was believed to contain the most iron, because it was the only one that advertised its containment of iron on the bottle. CVS was presumed to dissolve the fastest because it was the smallest pill and had a thin coating. The hypothesis was supported by the data. Nature Made contained the most iron with an average of 137 PPM (parts per million). CVS dissolved the fastest with an average of 15 minutes and 31 seconds. The approach was to test five common multivitamin brands and compare their iron content and dissolution time. The key results were, CVS brand dissolved the fastest, and Nature Made contained the most iron.

### **The Effect of Decrease in MCV-1 Vaccination Rates on Incidents of Disease**

*Cassie Couch, Sabot at Stony Point*

Recently, some people have been reconsidering the safety of vaccines because they are worried about the effect of vaccines on their children. As a result, some of these adults have ceased to vaccinate their children or themselves. The purpose of this research was to see if there is an inverse relationship between vaccine coverage and incidents of disease. This paper consists of data collected from three countries—Ethiopia, the United Kingdom, and the Netherlands—on MCV-1 vaccination rates and incidents of measles obtained from World Health Organization (WHO). The results of this research show that when there is a decrease in vaccine uptake in one country, it can affect many different countries. The results also establish that there are fewer incidents of disease when the vaccine coverage is over 90%. This supports the hypothesis that there is an inverse relationship between vaccine rates and incidents of disease.

### **The Cardiovascular Effect of Increased Swim Practice Time on Swimmers Age 11-**

*Abigail Fleenor, Sabot at Stony Point*

In competitive swimming, most swimmers swim many hours each week. However, there is no specific amount of practice time that has been shown to be ideal for any specific age group. The purpose of this study was to determine whether swimming more hours per week resulted in a difference in resting and post-exercise pulses and blood oxygen (POX) levels in 11 to 14-year old year-round swimmers. Two groups of swimmers were tested over three trials. Group One were swimmers who swim greater than seven hours weekly and Group Two were swimmers who swim two to seven hours weekly. Results showed a significant amount of overlap of ranges between the two groups as well as variability within each group. There was a single notable finding of a higher percentage of Group One swimmers with post-exercise pulses greater than 150 beats per minute. This does indicate that hearts were pumping harder in Group One swimmers in these trials. However, analysis shows no statistical significance between the two groups. Although this small study did not find a major difference between the two groups tested, other studies could measure heart rate continuously, consider pulse recovery time, or combine other factors, such as muscle fatigue, to provide better measurements of cardiovascular fitness.

**The Effect of Static and Dynamic Stretches on Flexibility Using a Modified Sit and Reach Box**

*Mackenzie Gregory, Home School*

The purpose of this experiment was to determine if flexibility of the lower back and legs increased more after performing static or dynamic stretches. This experiment was completed by using a modified sit and reach box. There were eight participants: four males, and four females. For every exercise, a male and a female of varying ages were paired together. Each participant was asked to complete the sit and reach assessment. Participants were required to sit on the floor with the back and shoulders against the wall and hands overlapping and stretched in front of the body. The legs were also in front of the body with feet shoulder width apart. The end of the ruler was then placed at the participant's fingertips and they were asked to reach as far forward as they could. They completed this task three times then spent five minutes on a previously assigned stretch. They then went back to the sit and reach box and three more measurements were taken. The results were found by taking the highest measurement from the set of three before and the highest measurement from the set of three after stretching for each participant. The difference was then found for every person and the mean was determined for the static stretches and then the dynamic stretches. The main reason for this experiment was to discover whether static or dynamic stretches improve flexibility more. The end results showed that the static stretches improve flexibility by 1.11125cm more than the dynamic stretches. It was also observed that males increased their flexibility more from static stretches than dynamic stretches and females increased their flexibility more using dynamic stretches than static stretches.

**The Effect of Color on a Butterfly's Diet**

*William Hahn, Mary Ellen Henderson Middle School*

The objective of my project was to find out how the color of a butterfly's sugar water can affect the amount of time the butterfly drinks from it. I took one butterfly and tested three

colors, as well as a control color, which was white, or the color of the cotton ball that soaks up the water and mimics a flower. The three colors were red, green, and yellow. I did three trials for each color with the same butterfly the whole time. The main results I found from this were that the butterfly drank the longest from the yellow (average of 444 seconds). Red came in second with 362 seconds, and the butterfly did not drink from the green sugar water in four days, which means it wasn't interested. When I include the control, it came in second with 421 seconds. I have concluded that the reason the butterfly didn't drink from the green color is that green usually signifies a flower's stem or leaf which holds no nectar for the butterflies. I also think the reason the butterfly drank so long from the yellow was that their favorite flower, a marigold is yellow.

### **The Effect of Gel Electrophoresis on the Migration of Different Colored Food Dyes**

*Irene John, George H. Moody Middle School*

For this science project, the concept of gel electrophoresis was tested. For the experiment, a gel electrophoresis chamber was created to discover how many components are in a variety of different color food dyes. The colors of food dyes used were blue, red, and green. The purpose of this experiment was to discover if the concept of gel electrophoresis can separate DNA molecules. That was tested by creating a gel electrophoresis chamber. Stainless steel electrodes were then placed at either end of the chamber and were then connected to wires. The wires were attached to a pack of batteries. Once the wires were connected, a drop of blue, red, and green food dye was dropped into the chamber. The dyes were then timed and measured with a ruler. It was hypothesized that if red, blue, and green food dyes were put through a gel electrophoresis chamber, then they would migrate to the other end of the well. That hypothesis proved to be incorrect, as the blue dye was the only dye to travel the full length of the chamber.

### **The Effect of Different Anticoagulants on the Height and Diameter of Blood Clots**

*Rohan Kurup, George H. Moody Middle School*

When humans experience cuts the body provides a physiological response called hemostasis in which a cycle called the coagulation cascade seals the cut by clotting blood. In this process, Platelets clump together to form plugs with little Fibrin Strands coming to act as the "glue" for the plug. Fibrin is created from Fibrinogen while Fibrinogen is from Thrombin which is created from Prothrombin through a process called amplification. The amplification process is when a group of proteins called clotting factors turn into other clotting factors until Fibrin is formed. An anticoagulant is a substance that inhibits the clotting of blood by interfering with the amplification process. The purpose of the project was to find the effect of different anticoagulant solutions on the clotting of blood. The research hypothesis is, if the anticoagulant solution (warfarin) is more concentrated, then the blood clots (represented by semisolid balls of alginate) would have the shortest diameter and shortest height. The experiment was conducted by making a solution of sodium alginate, water, and red food coloring. One drop of that solution was added to three different bowls that had the same amount of Calcium Chloride in each but a different percentage amount of each anticoagulant. The longest mean diameter of the alginate balls was 1% warfarin at 10.4 millimeters, while the shortest mean diameter was in the 0% Sodium Citrate at 4.4 millimeters. The greatest mean height was in 0% Sodium Citrate at 4.1 millimeters, while the shortest mean height was in 1% warfarin at 1.4 millimeters.

Based on the heights and diameters of the balls, there seems to be a correlation between the anticoagulant in the solution and the heights and diameters. It shows that the more concentrated the anticoagulant, the longer the diameter, while the shorter the height.

### **Why Does Blood Pressure Vary in Human Beings?**

*Shriya Majumdar, George H. Moody Middle School*

Learning how the heart functions and how it affects us is crucial, since it is a vital part of the body, and learning about your own body is necessary. If there was a mishap with your blood pressure, like it being too low or too high, then you could have an idea of what could be wrong with your heart and how to fix it. A simple way to learn something about the heart is blood pressure, which can be taken using a blood pressure cuff or monitor, placed around the upper arm. However, what exactly happens with blood pressure? If someone is a male or female, a child or adult, consumes more or less food, or athletic or does not perform much physical activity, then their blood pressure will change. However, the Systolic Pressure, the pressure in blood vessels while beating, is what gives a larger impact on the blood pressure as a whole. Generally speaking, the Diastolic Pressure, the pressure in blood vessels in between beating, doesn't change too much after exercise and some other activities, like caffeine or food, that increase Systolic Blood Pressure. In this activity, the experiment's readings of the Systolic Blood Pressure were around 130 mmHg for the highest level of exercise, which is understandable for a 12 year-old girl.

### **The Effect of Natural Antioxidants on the Heart Rate of *Daphnia magna***

*Sivani Nemani, George H. Moody Middle School*

The purpose of this experiment was to test out different natural antioxidants that most people have access to and record which one worked the best. Antioxidants are chemicals that fight oxidation. Oxidation can be harmful for the human body because it can cause oxidative stress, an imbalance between oxidants and antioxidants. High oxidative stress can cause chronic and neurodegenerative diseases. The hypothesis for this experiment was that if turmeric extract was introduced to oxidant exposed *Daphnia magna*, then the heart rate in BPM (beats per minute) would decrease. One *Daphnia magna* was selected, and its heart rate was measured in spring water, hydrogen peroxide, which was the oxidant, and then the antioxidant extract (turmeric, ginger, and garlic) to determine the effect of the oxidant and the antioxidant. The control of this experiment was, instead of adding an antioxidant to the water, no antioxidant was added. The *Daphnia magna* were placed into the spring water. Every independent variable tested in this experiment, other than the control, exerted some antioxidant properties. Out of the four levels of independent variables, the ginger extract reduced the heart rate of the oxidant exposed *Daphnia magna* the most efficiently with a 16.82% decrease in heart rate, followed closely by the turmeric extract at a 16.38% decrease. The garlic extract had an average percent decrease of 12.14%, and the spring water had an average of 8.44% decrease in heart rate. Turmeric and ginger had similar results because turmeric and ginger are both in the family *Zingiberaceae*. Ginger, turmeric, and a majority of the *Zingiberaceae* family are high in polyphenols. Polyphenols are micronutrients that are in many plant-based foods. Polyphenols contain large amounts of antioxidants. The high antioxidant capacity of the ginger and turmeric may be correlated to high amounts of polyphenols in them.

## **The Effect of Fluoride on the Thickness of Teeth**

*Manushi Nepal, George H. Moody Middle School*

Fluoride is a naturally occurring compound containing fluorine. It is often added to drinking water and toothpaste, and also occurs in many foods. Teeth are important parts of the body that help people chew food, smile, and talk. Fluoride is a key part in taking care of teeth and gums, strengthening enamel and protecting them from cavities. The purpose of this experiment was to see if the amount of fluoride in a toothpaste applied to a tooth altered the tooth's health. Since genuine human teeth were unable to be used, eggshells were taken as a substitute. The research hypothesis constructed for this experiment was if the amount of fluoride is measured, then the thickness of the eggshell will decrease the most from applying the toothpaste without fluoride. To test one variable, fifteen eggshells were required. Either the Tom's of Maine Silly Strawberry Fluoride Free Natural Kids Toothpaste, Crest Complete Whitening + Scope Multi Benefit Toothpaste, Aquafresh Extreme Clean Whitening Action Toothpaste or the Sensodyne Complete Toothpaste was then applied onto all 15 of the eggshells using a Colgate toothbrush. The next night, the toothpaste would be washed off and the process would repeat again for a week. At the end of the week, the thickness of each eggshell would be measured before placing them in Coke overnight. The next night, the eggs were removed and measured again to see if a change occurred. Results showed that the fluoride free toothpaste group had the lowest post-Coke thickness, supporting the research hypothesis. The group with 0.243% fluoride decreased the least and had the highest post-Coke thickness of all the other variables. The experimenter concluded from this that the amount of fluoride in a toothpaste was vital to the health of the teeth it [the toothpaste] was applied to.

## **The Effect of Different Silver nitrate Nanosilver on the Population of *Daphnia magna***

*Viswanath Subramanian, George H. Moody Middle School*

After University of Arizona students released a journal analyzing the environmental impacts of nanosilver, further studies have research other possible effects as well. However, most of these studies would explore extreme toxicity levels instead of cumulative effects. This led to the purpose of this experiment to determine how different silver nitrate nanosilver consisting of different substances such as propylene glycol, trisodium citrate, glycerin, and sodium hydroxide, would affect the population of a *Daphnia magna* culture. Each nanosilver was created using the same method, with a solution of silver nitrate, water, and the chemical substance, with PVP acting as a stabilizer. After this was done, it was applied to a *Daphnia magna* culture of 40 organisms, which has been already fed for four days. Following two days later, the population of *Daphnia magna* remaining was tallied, and this process was repeated for ten times. The results indicated that the nanosilver of silver nitrate and propylene glycol harmed the least amount of the *Daphnia magna* population (32 remaining, compared to the nanosilver of silver nitrate and trisodium citrate (27 remaining). The data supported the research hypothesis if different forms of nanosilver are applied to *Daphnia magna* cultures, then the nanosilver of silver nitrate and trisodium citrate will be more harmful. Based on the results of this study, there appears to be a direct correlation between the population of *Daphnia magna* and the different nanosilver applied. Before it can be concluded that the nanosilver

consisting of silver nitrate and trisodium citrate was the sole cause of a lower population, further studies will need to be conducted to find its apparent toxicity at a greater exposure.

## **Botany**

### **The Effect of Different Added Electrolytes on the Height of *Vigna radiata***

*Bhavana Adhikari, Mills E. Godwin High School*

The purpose of this experiment was to determine the effect of different added electrolytes on the height of *Vigna radiata*, commonly known as mung bean. As severe malnutrition plagues the Earth, the agricultural system has to provide for the population which is growing by millions. Because of the nutritional value of the mung bean, it is being recognized as a major crop that could help put an end to the worldwide epidemic of malnutrition. *Vigna radiata* plants were exposed to 0.02% electrolyte solution of potassium chloride, calcium chloride, magnesium chloride, and tap water, which was the control, for 21 days. It was hypothesized that if *Vigna radiata* plants were given the potassium chloride electrolyte solution, then the plants will grow the tallest. The results implied that different added electrolytes had a negative effect on the height of the mung bean. The plants given tap water grew the tallest and the plants given MgCl were the shortest. Multiple t-tests were performed on the data and overall, the data was statistically significant, with the exception of CaCl vs. MgCl. The results did not support the research hypothesis, since potassium chloride did not have the highest average height of *Vigna radiata* plants. It is believed that the results were due to the fact that the electrolyte solutions were made from salts and that the turgor pressure dropped in the plant cells, even though only a small solution of salt was given to each plant. This experiment could lead to further studies on which environment leads to optimal plant growth for mung beans or different ionic solutions on mung beans.

### **The Effect of Various Heavy Metals on the Mortality of Plant Root Border Cells**

*Haasita Akkala, Mills E. Godwin High School*

As various types of pollution are progressively deteriorating the environment, it is imperative to understand and try to restore its health. The intention of this investigation was to observe the effect of heavy metals from soil pollution on the mortality of plant root border cells (RBCs) to study soil pollution. It was hypothesized that if contaminants are in the soil of maize plants, then aluminum will be most harmful and detrimental to the plant's roots' health. Ten maize seeds were planted in each of four pots and grown for two weeks. Then Aluminum nitrate, Copper nitrate, and Lead nitrate were added to their respective pots and the plants were grown for another week. Afterward, the roots were dyed in order to be observed under a microscope, and the number of dead RBCs were set up in a proportion. The control in this experiment was the pot with no heavy metal added. Upon data analysis through a t-test, it was determined that all combinations were statistically significant except for the Aluminum nitrate versus lead nitrate with a t-value of 1.960 compared to the table value of 2.011. The Aluminum nitrate group had the largest mean suggesting that those roots suffered the most mortality. The Copper nitrate group had the largest standard deviation and variation within the data meaning that the data was the



least precise in this category. Ultimately, the results supported the research hypothesis. It is believed that the Aluminum is the most toxic to maize plants as more mortality is associated to have a direct relationship with the toxicity of the heavy metal.

### **The Effect of Phosphate and Potassium on Spinach (*Spinacia oleracea*) Grown with Saltwater**

*Maria Zamora, Mills E. Godwin High School*

The purpose of this experiment is to determine if Monopotassium phosphate has an effect on spinach growth when grown in the presence of salt. As of recent years, the increased mixing of saltwater with freshwater is being carried by storm surge towards the soil in farms. It was hypothesized that plants treated with a higher concentration (1.2g) of Monopotassium phosphate would grow more than those treated with a low concentration. The control used was 1.6 g of Monopotassium phosphate, as it is the optimal concentration for the amount of soil used. The concentrations were mixed in soil with five seeds of Spinach (*Spinacia oleracea*) per pot. Five milliliters of tap water were used for daily watering until the plants sprouted. After the plants sprouted, they were watered with 5 mL of a 5.8 g/l of salt every other day. T-tests were conducted on the data and it revealed that overall the data was not significant. The results showed that 1.2 g had the highest mean height, not supporting the hypothesis. Because macronutrients such as Potassium and Phosphorus are displaced by salt entering the plant, the addition of Monopotassium phosphate provided the plants the macronutrients previously displaced. The 1.2 g concentration enabled the spinach to have the most optimal results, implying that Monopotassium phosphate positively aids spinach growth. This research could lead to further studies that investigate lower amounts of Monopotassium phosphate paired with other salt tolerant plants.

### **The Allelopathic Effect of *B. oleracea italica* on the Germination of *B. oleracea botrytis***

*Ella Bryant and Michelle Zheng, Roanoke Valley Governor's School for Science & Technology*

Agriculture is an essential component for every civilization that entails proper crop rotation and companion planting. Crop rotation is the annual location transfer of crops, and companion planting is the process of pairing plants with those that benefit one another. For these processes, the knowledge of whether *B. oleracea italica* (broccoli) has allelopathic effects on *B. oleracea botrytis* (cauliflower) germination is important. Allelopathy is the effect of a plant on another plant by the release of allelochemicals. It was hypothesized that the allelochemicals in *B. oleracea italica* would inhibit the *B. oleracea botrytis*'s germination. In this experiment, the independent variable was *B. oleracea italica*; it had four concentration groups: 0%, 30%, 60%, and 100%. The dependent variable was *B. oleracea botrytis*. Both the germination, as indicated by when the radicle became visible, and radicle length were measured. 10 milliliters of solution were placed in each petri dish along with MS10 medium. There were 40 petri dishes with 10 trials per solution concentration. The germinated seeds were counted after 24, 48, and 144 hours. A Chi-Square Test was run for each time the germination was recorded. For the 24, 48, and 144 hours, all the p-values were less than the alpha value of 0.05 (p-values were  $1.2731 \times 10^{-12}$ ,  $7.1253 \times 10^{-8}$ , and  $4.3445 \times 10^{-8}$  respectively).

The p-value for the radicle lengths was less than 0.0001. Since each p-value is lower than the alpha value (0.05), there is a relation between the *B. oleracea italica* solution concentration to the development of *B. oleracea botrytis*. The averages of each radicle length decreased as the concentration increased. Therefore, the results support the hypothesis. This information will help the profit and productivity of farms with cauliflower.

### **The Effect of Various Herbicides on *Stellaria media* Deterioration**

*Kate Devitt, Mills E. Godwin High School*

The purpose of this experiment was to provide reliable data on the efficacy of various herbicides, as an alternative to Glyphosate and Sulfonylurea based solutions. Herbicides containing these chemicals were proven to be carcinogenic, environmentally hazardous, and ineffective due to genetic resistance across multiple plant species. With no readily available research on alternatives to these herbicides, farmers are left without the safe option necessary to maintain their business. Based on background research, it is plausible that if the efficacy of 5 different treatments is tested (treatment 1 [equal parts rubbing alcohol and water], treatment 2 [equal parts lemon juice and vinegar], treatment 3 [equal parts vinegar and Epsom salts with 1 teaspoon of dish soap/8 ounces of solution], treatment 4 [equal parts vinegar and water], and treatment 5 [water- control]) on Chickweed (*Stellaria media*), then treatment 3 will be the most effective at weakening the plant. The control (water) was chosen because it represented typical conditions for the plants. For this experiment 125 plants were grown with 25 for each of the 5 levels of independent variable. After growth, each plant was treated with their designated solution and then photographed at regular intervals as they deteriorated. From these photographs a VARI score was calculated and the initial and final scores were compared. The data indicated that Group 5 resulted in the biggest change in data. Seven out of ten t-tests came back as significant and the small SD ranges indicated precision in the experiment. These results were proven to be due to the independent variable and not chance.

### **The Effect of Magnets on Plant Growth Rate and Size**

*Malak Elsherbiny and Nicholas Morgan, Charles J. Colgan, Sr. High School*

### **The Effect of Road Salts on Chlorophyll Content of *Hydrilla verticillata***

*Elizabeth Eroshenko, Mills E. Godwin High School*

The purpose of this experiment was to determine if the type of road salt would have an effect on the chlorophyll content of *Hydrilla verticillata*. Salts are applied to make roads safer during or after inclement weather. However, they can flow into nearby bodies of water, negatively impacting the organisms living there. Plant growth, seed germination, leaf length, and chlorophyll content can all be decreased due by osmotic stress due to an increased salinity. For this study, *H. verticillata* plants were grown in water containing 100 mM of either sodium chloride, calcium chloride, magnesium chloride, or no salt (control). They were allowed to grow for seven days and were then ground into a solution to measure the absorbance using a spectrophotometer. This data was applied to equations developed by Arnon to calculate the total chlorophyll, chlorophyll a, and chlorophyll b contents. It was hypothesized that if sodium chloride was applied to *H. verticillata*, then it would cause the lowest total chlorophyll, chlorophyll a, and chlorophyll b contents. The results revealed that sodium chloride had the lowest chlorophyll levels; therefore, the

research hypothesis was supported. T-tests were conducted on the data and showed that all salts significantly decreased the amount of chlorophyll. However, there was statistically no difference in the amount of chlorophyll between different road salts. These results were likely due to higher variation in the data. This project can help determine which type of salt causes the most harm to plants in nearby bodies of water, allowing organizations to choose which salts to replace with alternate road treatments, minimizing environmental impacts.

### **The Allelopathic Effect of *M. officinalis* Organs on the Germination of *D. sanguinalis***

*Caroline Grant and Margaret Laflam, Roanoke Valley Governor's School for Science & Technology*

The purpose of this experiment was to determine the allelopathic effect of lemon balm on the germination and growth of crabgrass and ryegrass. It was hypothesized that crabgrass and ryegrass seeds treated with filtrates of lemon balm obtained from varying organs of the plant would experience a decrease in germination percentage and grass blade length, with the most significant inhibition produced by the leaves. Lemon balm was grown over a period of two months, after which the plants were separated into leaves, stems, and roots. These plant organs were ground, combined with distilled water (dH<sub>2</sub>O) and filtered multiple times to produce the final filtrates. After being autoclaved to neutralize any contaminants, 7 mL of each filtrate was pipetted onto its respective plates containing MS10 medium. Germination, as indicated by the radicle emerging through the outer seed hull, was observed after 24-, 48-, and 144-hour periods. Additionally, grass blade length was measured in millimeters after a 144-hour period. The same procedure was followed when analyzing ryegrass. After 144 hours, the proportion of germinated crabgrass seeds (56%) treated with leaf filtrate was significantly less than the others (Chi-Squared,  $p = 0.0244$ ). The leaf filtrate had a significantly lower average (4.8 mm) crabgrass blade length (ANOVA,  $p = 0.0000075$ ). Taking this into account, it was only deemed necessary to test leaf filtrate and dH<sub>2</sub>O on ryegrass seeds. There was not enough evidence to indicate that the germination percentage of ryegrass was significantly different (Chi-Squared,  $p = 0.504$ ). The mean grass blade lengths of ryegrass (6.13 mm) and crabgrass (4.8 mm) treated with leaf filtrate showed that the blade lengths were not significantly different (Two Sample t-Test,  $p = 0.340$ ). Therefore, one can conclude that the leaves of lemon balm significantly inhibited the germination and growth of crabgrass but only the growth of ryegrass, and thus is a viable candidate for a natural herbicide to prevent germination of unwanted grasses.

### **The Effect of Plant Species on the Phytoremediation of Petroleum**

*Estelle He, Mills E. Godwin High School*

The purpose of this experiment was to test the effect of plant species on the phytoremediation of petroleum. The plants species, *Medicago sativa* (alfalfa), *Festuca arundinacea* (Tall fescue), and *Cynodon dactylon* (Bermuda grass) were used. Oil spills and oil leaks cause contamination of petroleum products, gasoline being a common petroleum contaminant. Using plants to remediate petroleum contamination creates an inexpensive method to treat contaminated soil. It was hypothesized that Tall fescue (*F. arundinacea*) would remediate the most amount of the petroleum contaminant. Plants

were grown in gasoline contaminated soil to represent a petroleum contaminant. After 6 weeks of plant growth, the amount of total petroleum hydrocarbons in the soil was measured using a GC-MS and dynamic headspace. There was no control as there is no normal plant which remediates petroleum pollution. Data collected revealed *M. sativa* remediated the most gasoline (22.93 TPH) compared to *F. arundinacea* (25.88 TPH) and *C. dactylon* (24.84 TPH). A t-test was performed that showed *F. arundinacea* vs. *M. sativa* and *M. sativa* vs. *C. dactylon* was significant however *C. dactylon* vs. *F. arundinacea* was not significant. Results collected indicates the research hypothesis was not supported as *M. sativa* (alfalfa) remediated the most gasoline, not *F. arundinacea* (Tall fescue). Results obtained can be explained as *M. sativa* can promote the growth of petroleum degrading bacteria in the soil. *Medicago sativa* also increases microbial populations in soil and decreases soil toxicity of certain contaminants. Further research can be conducted to investigate how different combinations of plants can impact the degradation of petroleum contaminants.

### **The Effect of Motor Oil in Soil on the Growth of Lolium**

*Erin Hedrick, Central Virginia Governor's School for Science & Technology*

The purpose of this study was to determine if the growth of Lolium was impacted by the concentration of motor oil mixed into the soil. The hypothesis was that the higher amount of oil mixed into the soil, the less growth the Lolium would undergo. Four concentrations of motor oil were used in this experiment: a control, which had 0 g/kg, 25 g/kg, 50 g/kg, and 75 g/kg, all measured in grams of oil per kilogram of soil. Twenty samples per group had a three-week growth observation period after the different amounts of oil were mixed into the soil. Plant height was calculated using a metric ruler after three weeks of growth under grow lights with regular watering. A single-factor ANOVA with an alpha value set to .05 determined statistical significance with a resulting p-value of 3.29E-16. A Tukey test then determined statistically significant differences between all groups except the 25 g/kg and 50 g/kg, and the data supported the original research hypothesis, that the highest amount of oil concentration would result in the lowest amount of growth. The results suggested that ascending levels of motor oil mixed into the soil has a negative impact on the growth of Lolium.

### **The Allelopathic Effect of *P. montana* organs on the Germination of *L. esculentum***

*Merryn Isbell and Lillian Jamison, Roanoke Valley Governor's School for Science & Technology*

The purpose of this experiment was to better understand the allelopathic effect that *P. montana* organs would have on the germination *L. esculentum*. *P. montana* is an extremely invasive weed and can inhibit the growth of many other plants. Around Virginia and other southern states, *P. montana* is extremely common in many areas including road and the highway sides. In the United States alone, there is 1,158,306.4756 square kilometers of *P. montana*. This project could help to determine the exact effect each organ of *P. montana* has on *L. esculentum*. The growth of *L. esculentum*, a common garden plant in many southern gardens, could be at risk because of the rapid growth rate of *P. montana* which spreads up to 18.288 meters annually per plant. It was hypothesized that if a filtrate from the roots of *P. montana* is pipetted on the seeds of *L. esculentum*, then

the filtrate would inhibit the growth of the *L. esculentum*. Each Petri dish was prepared by first placing MS10 medium into each dish. Next, each filtrate was made and 7 ml of each was added to the agar in the Petri dishes. Then, 10 seeds of *L. esculentum* were placed in each petri dish and set into a tray and put under constant light at approximately 25°C. The germination of each seed was recorded after 24, 48, and 120 hours. The data indicated that each day the *L. esculentum* seeds continued to germinate and further grow. However, the *P. montana* root filtrate inhibited the germination more than any other filtrate. A Chi-Squared test was run to determine the P-value of the collected data. An additional step was taken to measure the length of each radical, and the hypothesis was tested using the Welches ANOVA. The test for all the germinated seeds showed that the P-value was 0.000001563424, meaning that the data suggests there was a significant difference between the germination of the seeds and their corresponding filtrate.

### **The Effect of Different Aquatic Hyperaccumulators on the Concentration of Lead in Water**

*Shivesh Joshi, Mills E. Godwin High School*

The purpose of the experiment was to find which aquatic hyperaccumulators had the greatest phytoremediation potential for lead (Pb). The hypothesis was that if different aquatic hyperaccumulators were used to remove lead from water, then *Azolla filiculoides* would be the most effective at removing lead from water. Information from this experiment could be used to optimize a cheap and environmentally safe method of removing a harmful contaminant from water. A solution of  $1.5097 \times 10^{-3}$  molarity solution of lead (II) nitrate and water was added to 100 Petri dishes. Then, 0.5 grams of a hyperaccumulator was added to 75 of the Petri dishes and left alone for a week. The 25 Petri dishes that did not contain a hyperaccumulator made up the control. At the end of the week, the remaining solution in each Petri dish was mixed with 0.030 grams of potassium iodide (KI) to create a solid precipitate in the form of lead (II) iodide. *Azolla filiculoides* trials had the highest mean of lead iodide left over, and a t-test that was performed indicated that the data was significant. The results supported the research hypothesis. It is believed that the results are due to lead having a higher bioavailability to *Azolla filiculoides*.

### **The Effect of Grafting Capsicum Annuum Serrano on Pepper Plants**

*Anvita Korrapati, Mills E. Godwin High*

The practice of plant grafting was introduced to humanity in 1400 BCE, changing the way people think in terms of horticulture now. This project illustrates the effects of grafting Serrano peppers on different pepper plants to find the best compatibility between the plants for a faster result. The tops of the Serrano pepper plant (scions) were cut and connected to the different bottoms (rootstocks) of Banana, Habanero, Pablano, and Bell pepper plants, through grafting tape. They were watered every day and their height was recorded every two days in a month. There was no control since grafting was uncommon and there is not a specific plant combination to compare to. It was hypothesized that if the Serrano pepper scion was grafted on to the rootstock of a Banana pepper, then that plant would yield the highest plant growth. The results revealed that the grafted Banana pepper plant had the highest rate of change in growth and was the tallest plant. Second highest was Habanero pepper plant, third highest was

Pablano pepper plant, and the least and shortest plant was the Bell pepper plant. A t-test was done on the data of all of the plants vs. each other, and it revealed that the data was significant. The results supported the research hypothesis: it is believed that the results are due to the similar chemical make-up of both the Banana and the Serrano pepper plant. This research could lead to further studies in plant hormones and the internal workings of grafting.

### **The Effect of Sound Pollution on Plant Growth**

*Sricharan Lankalapalli, Mills E. Godwin High School*

The purpose of the experiment was to study the effect of the audible frequencies on plant growth. Many people in modern society are unable to get enough food to feed themselves and their families, and so there is a need to find a solution to increase the production of food. Studies showed that frequencies affect the growth of plants, so if discovery can be made to find the frequencies that positively affect the plant growth, it could help in solving the problem of world hunger. In this experiment, the effects of four different frequencies on plant growth was researched. The research hypothesis formulated was, if the plants were exposed to a frequency of 7000 Hz, then they would grow more. One group of plants were not exposed to any frequency, which was used as the control group. This experiment was conducted for four weeks, where plants were exposed to their assigned frequencies every day for an hour. The height of the plants was measured every three days. At the end of the experiment, the data collected was shown to be significant based on t-test. The results showed that the plants exposed to 5000Hz grew the most, which does not support the research hypothesis, but it supports the study that sound has a significant effect on the growth of plants.

### **The Effects of Aquaculture Species on Plant Growth**

*Logan Layne, Chesapeake Bay Governor's School for Marine & Environmental Science*

### **The Role of the IPK1 and ITPK1 Genes in Plant Sucrose Sensing**

*Sophia Link, Blacksburg High School*

Inositol phosphates are an important plant signaling molecule whose role in nutrient sensing pathways could help lead to advancements in crop and environmental sciences. This study sought to determine the role of the inositol phosphate InsP6 in the sucrose sensing pathway of *Arabidopsis thaliana*. To do this, loss of function mutants of the IPK1 and ITPK1 genes, plants that overexpress the IPK1 gene, and wild type plants were grown on no sucrose and 3% sucrose plates. Root length measurements were collected, and two-sample student t-tests were used to test for statistical significance between the altered plants and wild type plants on each plate. It was hypothesized that *ipk1*- and *itpk1*- mutants would be longer on no sucrose and shorter on 3% sucrose when compared to wild type; IPK1OE plants were expected to have an opposite response. The *ipk1*- plants were found to be significantly shorter on 3% sucrose plates, and the *itpk1*- plants were significantly shorter on both plate type. The IPK1OE plants showed no significant differences to wild type in any conditions. These results indicate a role for InsP6 in plant sucrose sensing pathways and a role for InsP4 and InsP5 in plant root growth and seed viability.

## **The Effects of Different Concentrations of Copper sulfate on the Germination Time of *Solanum lycopersicum* Seeds**

*Nishaanth Mulpuru, Mills E. Godwin High School*

The purpose of this experiment was to find the effects of different copper sulfate concentrations on tomato seed germination time. Fertilizers and pesticides containing high levels of heavy metals are used by farmers to kill insects and fungus, but farmers are not realizing how excess copper affects plants. Tomato seeds were treated with either the 100 mg/L (6.265  $\mu$ M) or the 300 mg/L (18.796  $\mu$ M) solution. The tomato seeds were given twenty-three days to grow, and their germination time and growth was measured. The control that was used in the experiment was deionized water. It was hypothesized that tomato seeds treated with the 300 mg/L solution will grow less and take longer to grow than the 0 mg/L and 100 mg/L solutions. The results revealed that tomato seeds treated with the 300 mg/L solution took, on average, five days longer than the 100 mg/L solution and nine days longer than tomato seeds treated with the control. A t-test was done on the data, and it revealed that the data was statistically significant for all three data sets. The results supported the research hypothesis. The results are due to the fact that copper toxicity changes the catalytic function of enzymes and decreases cell division; furthermore, the tomato seeds experience a poor break down of starch due to low amylase activity. Further studies that can be investigated include the effect of different heavy metals on tomato seeds and how CuSO<sub>4</sub> affects other plants.

## **The Effect of Sunlight on Mycorrhizal Network Quantity in Soil and Growth in Plants**

*Noah Portner, Washington-Lee High School*

The purpose of this research was to determine whether mycorrhizae (microscopic symbiotic fungi) influence the growth of plants through their mycelium network, and whether plant health affects mycorrhizae. Previous research has suggested that mycelium networks transfer nutrients between plants, and an experiment was conducted to determine whether this would occur among group of bean plants. Two hypotheses were tested. The first hypothesis that in shade conditions plants growing with mycorrhizae will grow better than plants growing without mycorrhizae, while unshaded plants that share the same mycelium network would do worse. The second hypothesis was as the amount of shade is increased, then the amount of fungus on shaded plants would decrease, while fungus on other plants would remain unaffected. To quantify results, two independent variables were used: percent shade (0%, 33%, 66%, 100%) was used to affect the health of plants, and presence/absence of added mycorrhizae was used to see how fungi affected plant health. The amount of fungi on plant roots was also measured. Both hypotheses were supported. The data indicate that adding mycorrhizae may help weaker plants while simultaneously harming adjacent plants (by transferring nutrients to the weaker plants). It was also seen that the underground mycelium network was only adversely affected when the plant nearest them was subject to shade. This suggests while adjacent plants were harmed by fungal linkage to dying plants, the fungi itself was not harmed.

## **The Effect of Glycerol Concentration on Chamomile Freezing- induced Dehydration Rates**

*Esha Sharma, Mills E. Godwin High School*

The objective of this investigation was to explore the principles of cryogenics through a study researching the effect of varying concentrations of glycerol, a type of penetrative cryoprotectant, on the freezing-induced dehydration rates and recovery growth rates of recalcitrant chamomile plants. The preservation of plant tissue by cryogenic means is proven to be a cost-effective and reliable way to ensure minimal loss of plant matter over a long period of time during frost seasons, especially in terms of agriculture and crop retention. Prior to initiating the experiment, it was hypothesized that if a 25% glycerol concentration is used in the planting medium, the plants exposed to that concentration will have the lowest dehydration rate and greatest recovery growth. Chamomile plants were grown from seed for two weeks, and later given the planned concentrations of glycerol—0% (control), 5%, 15%, and 25%—before being exposed to freezing temperatures. Afterward, the sprouts were reintroduced to normal conditions to study recovery growth. Following the examination of results, it was discovered that there was, in fact, a negative correlation between glycerol concentration and total recovery growth in chamomile; therefore, the hypothesis was not supported. Statistical t-tests additionally showed that when the 0% glycerol level was compared to any other level, all results were significant and assumed to not be based on chance. The negative correlation is likely due to too great of an osmotic shrink in the plant cells when the cryoprotectant was applied causing severe wilting. On the contrary, the 0% level had the greatest recovery growth due to not only an absence in glycerol, but also a high lipophilicity, or essential oil content—a natural, compatible cryoprotectant in chamomile plants.

**The Effect of Different Essential Oils on the Growth of  
*Tagetes erecta***

*Emma Smith, Clover Hill High School*

**Effects of Different Fertilizers on *Phaseolus vulgaris***

*Michaela Tate, Chesapeake Bay Governor's School for Marine & Environmental  
Science*

A common question about garden fertilization is what type of fertilizer will get the best results out of plants, whether it be flowers or food. The different fertilizer types could be overwhelming to someone who has not had much experience with gardening. After getting used to and understanding the basics of gardening, it becomes clear that there are two basic types of fertilizers. There are chemical fertilizers and organic fertilizers. The main types of fertilizers include organic and inorganic types. Organic types are made of organic materials, as expected from something with the name organic in it. Inorganic fertilizers are mostly ammonia diluted with water when they are ready to be added to the plants. These bean plants (*Phaseolus Vulgaris*) have the possibility to be pole and bush beans. The difference between the two is that the pole bean needs support, because it's taller and thinner, while the bush bean is shorter and thicker. The different experimental groups were the chemical fertilizer, natural advertised fertilizer, straight pig manure, and a control, which is no fertilizer added. The experimental groups were tested for the mass of the beans that each of the plants from the groups produced. The p-values given in the Anova: Single Factor test gave reason to reject the null hypothesis. Therefore, the different types of fertilizers do affect the mass of the garden beans. When producing



beans for profit or consumption, the beans having more mass is never a bad thing, and always a good thing.

### **The Effect of Nitrogen, Phosphorus, and Potassium Fertilizers on the Growth of the Common Waterweed, *Elodea canadensis***

*Katryn Watson, Chesapeake Bay Governor's School for Marine & Environmental Science*

## **Chemical Science A**

### **The Effect of Different Clothing Treatment Chemicals on the Strength of Cotton Fabrics**

*Aaryan Asthana, George H. Moody Middle School*

Cotton is one of the most used fibers in the world, but people may not know that chemicals could be affecting the strength of it. The purpose of the project was to test the effect of three commonly used clothing chemicals: detergent, fabric softener, and bleach, on the strength of cotton. Detergent is used for removing soil, softener is for providing more smoothness, and bleach uses oxidation to remove color impurities from fabric. Cotton threads were treated by these three chemicals and tested for strength by attaching them to a bucket and placing incremental weights till the thread snapped. The results indicated that detergent increased the strength, having a mean of 1689g from a control mean (untreated thread) of 828g. For bleach, the strength was decreased to 72g, and fabric softener showed a slight decrease on the breaking strength. T-tests performed showed a significant difference between the means of the groups ( $t=55.5 > 2.262$ ;  $t=4.560 > 2.144$ ;  $t=|-15.508| > 2.228$  at  $\alpha=0.05$  and  $df=9$ ). The data supported the research hypothesis that fabric softener would decrease the strength of cotton. Based on the results, it was possible detergent increased the strength due to the hardening of residue on the thread. Bleach has chlorine, which is caustic, giving an explanation of why the thread weakened. Fabric softener contains lubricants, meaning they likely decreased the internal friction of the thread causing easier fraying. These results could have been more conclusive through the means of using an ASTM-D5035, meant for testing fabric strength by elongating it slowly.

### **The Effect of Acid on Aluminum**

*Aurnab Barua, Thomas Jefferson Middle School*

The purpose of this study was to observe the effect of different corrosive acids on aluminum. The independent variable was the type of corrosive acid that was used in the experiment. The types of the independent variable were citric acid and hydrochloric acid. The control group was the group with aluminum wires and no corrosive substance of any sort. The dependent variable was how much the mass of the aluminum wires was affected by the corrosive acids. The constants were the amount of aluminum wires and amount of acids used, the amount of feet of metal wires used in the experiment, the amount of beakers and graduated cylinders, and the testing environment. The hypothesis was that hydrochloric acid will cause the most loss of mass of aluminum. Then, three groups were set, metal wires that came into contact with no substances (the control), metal wires that came into contact with citric acid, and the metal wires that came into contact with HCl (hydrochloric acid). There were 5 metal wires in each respective group. The experiment

took place over a 24 hour period. The results showed that hydrochloric acid corroded the metal wires the most and created the largest loss of mass. These results supported the hypothesis. In conclusion, the primary finding was that hydrochloric acid was much stronger than citric acid when it came to corroding metals.

### **The Effect of Different Types of Rocks on the pH and Phosphate Levels of Water**

*Dhruva Barua, Thomas Jefferson Middle School*

The purpose of this study was to observe the effect of different types of rocks on the pH and phosphate levels of water. The independent variable was the different types of rocks. The experimental group included: quartz, sandstone, and shale. The control group was a set of trials with no rocks in the water to provide a framework for original pH and phosphate levels. The dependent variable was the pH and phosphate levels of the water. The constants were the amount of water given in each trial, dissolving time, the temperature at which the rocks were kept, and amount of rocks. The hypothesis was: If the rocks are tested for their effect on water quality, then shale will cause the greatest increase in the pH of water, and sandstone will cause the highest phosphate levels in the water. The researcher gathered 60 grams of shale, quartz, and sandstone from Four Mile Run stream. Then the researcher crushed the rocks into dust to expedite the dissolving process of the rocks when put into water. Lastly, the researcher set up 20 cups in 4 rows and 5 columns, added 500 mL of water into each cup, distributed all equal amount of rocks into each column, each row for a different level (last row for control), and waited two weeks to record each cup's pH and phosphate level. The results of this study suggest that quartz and shale may have an impact on Four Mile Run stream's alkalinity. The results reject the hypothesis. In conclusion, the study suggests that rocks increase the pH of water and, depending on the type, can affect the phosphate levels both negatively and positively.

### **Using pykrete as a cooling device**

*Logan Blanchard, Sabot at Stony Point*

This paper compares the cooling properties of a standard ice pack to homemade pykrete. Pykrete is a composite material made up of wood pulp frozen in ice. Toxic chemicals within ice packs can be consumed by children who think the chemical substance within is candy or a slushy. The chemicals can also leak into food and drink that is later consumed, which can be harmful to animals and humans causing illness and/or death. The elimination of these ice packs would reduce these harmful events and decrease the amount of pollution on the earth of toxic chemicals and plastics. The experiment was approached by testing homemade pykrete and a standard ice pack called a EZ-Freeze® ice block to see which kept the inside of an insulated bag, cooler. The results showed that the homemade pykrete block maintained its low temperature the same as the standard EZ-Freeze® ice block.

### **Change in Salinity and pH levels of Creek Water when Filtered Through Microwaved Graphene Nanoplatelets**

*Stan Craig, Collegiate School*

Graphene has been found to be effective in its filtration capability and effective in the field of electronics. I aimed to test if microwaving graphene nanoplatelets could enhance graphene for filtration of creek water. Many communities across the globe suffer from a

lack of sustainably clean water, and graphene filtration has the potential to be pivotal in solving these clean water epidemics with its light and simple chemical design: a honeycomb pattern. By trapping the powder-like graphene flakes between filter paper, I let distilled water flow through to the funnel to determine if graphene changed the water's pH or salinity levels. I repeated the filtering process with graphene microwaved at 1000 watts for 60 seconds. I then filtered local creek water with non-microwaved and microwaved graphene. Graphene nanoplatelets can be a potentially dangerous substance, so I maintained great care and precautions when handling the material. I found that when distilled water filtered through the graphene, its pH and salinity levels did not change; they stayed at 6 and 4.9 ppt respectively. When the creek water was filtered through non-microwaved graphene, the salinity level had a new slightly lower average of 4.84 ppt (which was not significantly different), and the pH level for creek water filtered through non-microwaved graphene stayed at 6 with the exception of one sample that became 6.5. When filtered through microwaved graphene, the salinity again maintained a consistent level; but interestingly, the pH level raised to a neutral pH of 7 in every sample. It is notable that the microwaved graphene nanoplatelets significantly altered the creek water's pH level from a slightly acidic 6 to a neutral 7. Microwaved graphene has the capability to be pivotal in water filtration.

### **The Effect of Dairy Milks on Thickness of Kefir**

*Charlotte Cunningham, Swanson Middle School*

Kefir is a fermented dairy milk containing bacteria and yeast strains that is growing in popularity for both its taste and health benefits. The bacteria feeds on the lactose in milk during the fermentation process and, as a result, can provide benefits to those with lactose intolerance or digestive issues. The purpose of this experiment was to find how the presence of kefir cultures affects the thickness of dairy milks. The hypothesis was if kefir cultures are present in dairy milks, then whole milk kefir will be the thickest because whole milk has the highest fat content. Thickness was determined by recording the time in seconds it took 30mL of each liquid to drip out of a turkey baster into a cup. The two largest flow time differences were found between whole milks and whole milk kefirs. Nonfat milk and nonfat milk kefir had the lowest difference. Due mainly to the high starting milkfat, the whole milk kefirs were the thickest, and nonfat milk was the least thick due in part to its lack of milkfat. The findings are important for consumers with a lactose-intolerance, who prefer milk for its many important vitamins and minerals, or have preferences for thickness when drinking or using in recipes. These findings could also be of interest to people diagnosed with Dysphagia who use thickened liquids to help with swallowing and to prevent aspiration.

### **The Effect of Different Analgesics on the Dissolving Time in a Carbohydrate Solution**

*Shriya Das, George H. Moody Middle School*

Pain management has been practiced since the earliest humans thousands of years ago. Starting from the Stone Ages, humans have been trying to find effective remedies to things like headaches, cramps, back pain, arthritis, and throbbing injuries. Pain remedies were also needed for physical trauma, degenerative disorders, and uncontrolled pain following surgery. After many years of encountering problems with an analgesic called opium, which became an addictive drug, over the counter painkillers have been

developed and made available to those who need it internationally. The purpose of this project was to determine how different over the counter analgesics dissolve when combined with a common carbohydrate in an environment similar to the stomach. Research has conveyed that analgesics are more likely to dissolve faster when taken with carbohydrates. Tylenol, Motrin, Advil, and Bayer Aspirin were the four analgesics which were tested. Each type of capsule was coated in a layer of cornstarch solution and then put into a white vinegar and cranberry juice solution. The pH of each of the combined solutions was then checked every 10 minutes to record whether not the acidity increased or decreased to determine the dissolving state of each of the solutions. The results indicated that Tylenol dissolved the fastest out of the four painkillers with a mean pH of 3.0. In addition, Tylenol and Motrin were the only analgesics which dissolved fully in the white vinegar and cranberry juice mixture. At the end testing period, the liquid Ibuprofen inside of all of the coated Advil Gel tablets was gone, but the gel coating remained the same. Whereas nothing happened to the Bayer Aspirin. However, at the end of the 20 minute testing interval, all of the tablets lost their cornstarch coating. Ultimately, the data supports the research hypothesis that analgesics dissolve faster when taken with carbohydrates in the stomach.

### **Reliability of Red Cabbage Juice strips as a pH Indicator Used to Test Date Rape Drugs**

*Isabel Decker, Sabot at Stony Point*

Date rape drugs have been around for about three decades and their use is becoming more widespread among young adults and teens. This experiment was conducted to see if red cabbage juice strips could be used to detect for drugs/substances in an alcoholic drink (specifically vodka) by testing changes in pH levels. The red cabbage juice strips were tested with six different substances: plain vodka and vodka with additives of different acidity to simulate the possible changes made by date rape drugs. Based on the red cabbage juice pH color scale five out of the six different additives (including the control) had colors that matched the pH level. In conclusion the red cabbage juice strips were almost 100% successful at reading the pH level of the contaminated drinks, but some of the results were affected by errors so the experiment was not completely successful however the red cabbage juice strips did work for five out of six of the experiments.

### **The Amount of Vitamin C in Tablets Based on the Brand**

*Alexander Dillon, George H. Moody Middle School*

Vitamin C keeps people's bones, skin, blood vessels, and other tissues healthy. The Food and Nutrition Board recommends adults consume 75-90 mg Vitamin C daily, mostly from their diets. However, Vitamin C supplements are often used to treat colds. There are many brands of Vitamin C, none of which are regulated by the Food and Drug Administration, although a few are regulated by the US Pharmacopeia (USP). USP brands are regulated to ensure the pills' potency matches the labeled potency. This experiment evaluated the potency of different brands of Vitamin C for consistency with the labeling. It was hypothesized that a USP brand Vitamin C (control) would have a significantly higher percentage of tablets that match the label than non-USP brands. Ten, 500-milligram tablets of five different Vitamin C brands (one USP and four non-USP) were tested for the amount of active ingredient per tablet. Based on an oxidation/reduction reaction, solutions of the Vitamin C tablets were titrated by using an iodine solution with

a starch indicator to determine the amount of Vitamin C per tablet. This research found that only two brands of Vitamin C, the USP brand and one non-USP brand, had tablets with potency  $\pm 10\%$  of the labelled amounts, and the USP brand had significantly more tablets that matched the potency labeling than the non-USP brand (80% vs 20%,  $x^2=6.8 > 3.841$  at  $df=1$ ,  $p < 0.05$ ). The other three non-USP brands had no tablets with potency within  $\pm 10\%$  of the label. Based on these data, USP-brand Vitamin C tablets appear more likely to match the labeled potency than non-USP brand Vitamin C tablets. However, this study used a manual titration process to assess Vitamin C concentrations in tablets, and an automated technique would likely be more precise. Future research should assess the effects of environmental factors like humidity and light on Vitamin C levels in tablets, including the additive effects of environmental factors and the less-than-labeled potency of many brands of Vitamin C. Such research could be important to patients taking Vitamin C for health reasons.

### **What Kills Ice Without Killing the Earth?**

*Megan Dooley and Libby Moir, Swanson Middle School*

### **The Effect of Butter Substitutes on the Density of Vanilla Cupcakes**

*Samantha Douthit, Sabot at Stony Point*

The purpose of this experiment was to determine if there was a butter substitute that mimicked the effect that butter has on baking cupcakes. Butter contains many unhealthy fats, and if a substitute was found to have enough similar properties, then baked goods could have more nutritional fat. The hypothesis stated that the cupcakes made with butter substitutes would not have very much difference compared to cupcakes made with butter. However, the I Can't Believe It's Not Butter (ICBINB) would be more effective because it is marketed as a butter alternative. The cupcakes were made according to a standard recipe using both butter and butter substitutes. After cooling, the mass of the cupcake was measured with a triple beam balance, then put in a beaker with 300 mL of sugar to mimic liquid displacement and measure volume. The values of mass and volume were divided to find density. Density is the closest way to measure texture quantitatively, as well as find the most effective butter substitute. All of the substitutes have a very close average density, therefore the hypothesis was supported. The pumpkin had the lowest density values with an average of 0.381 g/cm<sup>3</sup>, the avocado with an average of 0.481 g/cm<sup>3</sup>, the I Can't Believe It's Not Butter with an average of 0.394 g/cm<sup>3</sup>, and butter with an average of 0.411 g/cm<sup>3</sup>.

### **The Effect of Different Substances on the Prevention of Rust**

*Marlena Gutshall and Finley Odar, Gunston Middle School*

The purpose of this investigation was to find out if different substances prevent rusting on metal, specifically steel. This experiment is important because a lot of objects rust, and rusting can cause machinery to not function properly. The scientists approached this question by applying different substances to a sheet of steel and recording the percentage of rust on the sheet of steel over the course of four weeks (twenty-eight days). The substances that the scientists tested were spray paint, hot glue, car wax, canola oil, and the scientists left one sheet of steel blank as the control. The results showed that canola oil was the best prevention for rust out of the materials tested, it only rusted 0.07% each day. The conclusion was that the hypothesis was not supported; hot glue was not the best

prevention for rust, it rusted 1.35% each day. The objective of this experiment was to find out which substances would prevent rust the best. The objectives were met because the scientists found out that canola oil and car wax prevent rusting because wax and oil both repel water.

### **The Effect of Carbonated Water pH on Tooth Enamel**

*Nolan Hoover, Sabot at Stony Point*

This project tested the effect of carbonic acid on tooth enamel using a HANNAH instruments calcium checker. The hypothesis was that, the lower the pH of the solution, the higher concentration of calcium in the solution. The testing consisted of placing teeth in acidic seltzer solution and testing the solution for calcium after the teeth were removed. The data recorded indicates proof of the hypothesis. pH 2.0 shows the most calcium concentration, meaning the most enamel was eroded, and pH 4.0 shows the lowest calcium concentration, meaning the least enamel was eroded. There is minimal variability in the data points, meaning more accurate data and more accurate results

### **The Effect if Different Types of Food on the Amount of Biofilm Produced by *Streptococcus mutans***

*Allison Ip, George H. Moody Middle School*

### **The Effect of Temperature on Radioactive Decay**

*Ishan Joshi, George H. Moody Middle School*

In the month of February in 1896, a man named Henry Becquerel exposed potassium uranyl sulfate to sunlight and then placed it on photographic plates wrapped in black paper, believing that the uranium absorbed the sun's energy and then emitted it as x-rays. This was when the recordings of radioactive decay was first discovered. Radioactive decay happens when an unstable atomic nucleus spontaneously changes to a lower-energy state (Baird, 2015). The purpose of this project was to determine if different temperatures affected how much radioactive decayed particles were seen with temperatures of . 5 trials were made for each amount of temperature tested. To make the cloud chamber, there was dry ice and a small radioactive material, which were both put together at the same time in order for the alpha and beta particles to be seen. Second, the amount of dry ice changed after it was tested 5 times of the same temperature and quantity. Finally, it was recorded. Each trial was measured for amount of times a decayed particle was seen. The results show that the  $\frac{1}{2}$  block of dry ice (-54.65°F) with a mean of 19 was the one that made the most particles appear while the  $\frac{1}{8}$  block of dry ice (-13.66°F) having a mean of 6.2 had the least amount of particles seen. The data shown proved the hypothesis that if there was an increase in the temperature levels, then that would cause less decaying radioactive particles to show up. Based on the data of this experiment, there is a correlation between the temperature and the radioactive decaying on how many decayed particles can be seen with a colder temperature. A conclusion can be made that temperature does affect how many decayed particles can be seen with a colder temperature.

### **The Effect of Different Amounts of Detergent on the Neutralization of Lemon Juice**

*Abigail Kant, Thomas Jefferson Middle School*

The purpose of this study is to find the effect of different amounts of detergent on the pH level of lemon juice. The independent variable was the amount of detergent. The experimental group was 20 ml, 50 ml, 90 ml, 120 ml, and 150 ml. The control group is 0 ml of detergent added. The dependent variable is the ending pH of each solution. The constants are the amount of lemon juice, heat, amount of starting liquid, and the person performing the experiment. The hypothesis was: If 90 ml of detergent is added to 90 ml of lemon juice then the ending pH will be neutral (pH of 7). Different levels of detergent were added to bowls with 90 ml of lemon juice (0 ml, 20 ml, 50 ml, 90 ml, 120 ml, 150 ml). The solutions were immediately mixed until dissolved. Immediately after the pH was measured and then recorded. The results showed that more than 150 ml of detergent are needed to consistently neutralize the lemon juice. This rejected the hypothesis that: 90 ml of detergent is needed to neutralize lemon juice. In conclusion, the study suggests that more than 150 ml of Kirkland Ultraclean detergent should be used to consistently neutralize lemon juice.

### **The Effect of Different Pain Relievers on the Solubility in Simulated Stomach Acid**

*Harish Krishnakumar, George H. Moody Middle School*

When one takes medicine, it needs to dissolve in order to be passed into your bloodstream to have an effect. On the other hand, the drug needs to be packed into a small, dense pill to make it easier to swallow. The faster a pill dissolves in stomach acid, the faster the pill will have an effect. Society would benefit to find out which branded pill would have a faster effect to solve headaches and other nagging pains. The purpose of this experiment was to determine the effect of different pain relievers on the solubility in simulated stomach acid. If Tylenol is dropped into simulated stomach acid, then it will dissolve at a faster time than other common brands. These brands will be decided based on the availability at 4 different stores in the Richmond area. (Walgreens, Walmart, Target, and CVS Pharmacy) The branded pills will be tested by dropping them at a height five centimeters into 150 ml of simulated stomach acid. The time will be taken by a stopwatch and recorded in a notebook. There will be three trials for each Tylenol, Advil, Aspirin, and Aleve. The results indicated that Tylenol dissolved at an average of 2 minutes, 20 seconds and 14 milliseconds, Advil dissolved at an average of 4 minutes 52 seconds and 37 milliseconds, Aspirin dissolved at an average of 3 minutes 37 seconds and 9 milliseconds, and Aleve dissolved at an average of 11 minutes 9 second and 60 milliseconds. The data supported the hypothesis that if Tylenol is dropped into simulated stomach acid, then it will dissolve at a faster time than other pain relievers. Based on the times determined from each pain reliever, Tylenol affects the body faster because it is full of small holes which exposes it to more liquid. Tylenol also doesn't have much of an outer coating.

### **The Effect of Different Bromelain Containing Substances on Removing Knox Gelatin**

*Anne Licato, Swanson Middle School*

Synchronized swimming is an Olympic sport that requires the athlete to secure their hair by brushing on a thick layer of hot liquid Knox brand gelatin and allowing it to harden before competing. After the swimmers compete, they must then remove the hardened Knox gelatin from their hair. The hardened gelatin is difficult to remove. For this

experiment, substances containing one special ingredient, bromelain, were used. Bromelain is a protective enzyme found in pineapple that can break down the proteins in gelatin. The purpose of this experiment was to determine the most effective way of dissolving Knox gelatin using four bromelain containing substances: bromelain extract, bromelain supplement pill, bromelain protein powder, and fresh pineapple. It was hypothesized that fresh pineapple would be the most effective because bromelain is derived from pineapple. Swimmers getting in and out of the pool for competition was simulated by saturating the gelatin with water before testing the different bromelain containing substances. The bromelain extract removed the most gelatin with an average of 0.562 grams of gelatin removed. Next, the bromelain pill removed an average of 0.188 grams of gelatin. The fresh pineapple and bromelain protein powder did not remove any gelatin, and they both increased the mass of the gelatin. The mass increase was possibly due to absorption of water or residual bromelain solution remaining on the gelatin. Bromelain extract appears to be a possible solution to removing Knox gelatin from synchronized swimmers' hair.

### **The Effect of Acidity and Salinity of a Liquid on the Melting Time of Ice**

*Daniel Lim, George H. Moody Middle School*

This study attempted to explore how the acidification of the sea directly influences sea ice melting and indirectly affects sea ice melting by altering the levels of salinity. Even though not much research has explored this topic, it is important to understand the impact of acidity and salinity on sea ice melting because the effects of the continued melting of sea ice would bring devastating consequences. Moreover, the environmental change would not just affect the Polar Regions, but it would also affect Virginia coastline neighborhoods as well. The study proposed two hypotheses – a positive relationship between levels of acidity and sea ice melting time and a negative relationship between levels of salinity and sea ice melting time based on the colligative properties and the heat convention respectively. The experiments were conducted to collect data. The results of ANOVA and t-test supported the proposed hypotheses. The researcher found that out of the three levels of acidity, the sea ice in the high level acidity condition melted the fastest, the sea ice in the lower level of acidity melted the second fastest, and the sea ice in the freshwater melted the slowest. For the second hypothesis, the sea ice in the high level of salinity melted the slowest, the sea ice melted the second fastest in the low level of salinity, and the sea ice in the freshwater ice melted the fastest. The research findings, limitations, and suggestions for future research were addressed in the discussion and conclusions section.

### **The Effect of Different Chlorinated Water Exposure Times on the Strength of a Strand of Hair**

*Marlise Lucas, George H. Moody Middle School*

Chlorine has been around for a long time, even before it was known to be an element. Chlorine was used in Chloroform, medicines and as poisons in the past. There have been many written accounts of a Chlorine gas that was used during World War I to kill thousands of soldiers because it is so toxic. Chlorine has been used to help and harm people throughout history and it has always been a part of our lives in many ways we didn't know. One of the most common places to find Chlorine is in a swimming pool,



though it can damage hair and skin. The purpose of this experiment was to determine which exposure time to chlorinated water hair was less susceptible to break in. The research hypothesis for this experiment was: If the hair was exposed to Chlorine for 60 minutes, then the hair would be the weakest. Three bowls of chlorinated water were set out and labeled for different times: 10 minutes, Thirty minutes and sixty minutes. The control was not exposed to chlorinated water. The strands of hair were cut to the same size and placed in the bowl with the proper exposure time. Then they were tested using a Dixie cup of quarters and the weight that each strand of hair was able to hold was recorded. Whichever exposure had the highest mean of weight was deemed the strongest exposure time. The results were determined by finding the mean, median, and mode of the different exposure times. The 10 minutes exposure time had a mean of 1.81 grams and the 30 minutes exposure time had a mean of 1.39 g. The 60 minutes exposure time had a mean of .99 g. The control had a mean of 2.36 g. The data did support the research hypothesis that 60-minute exposure time would be the weakest and hold the least amount of weight. Based on the different weights determined in the experiment, the no exposure time kept the strongest hair followed by a 10 minutes exposure time. Therefore, no exposure time was concluded to be the best amount of chlorine exposure time for hair. 60 minutes harmed the hair the most and weakened it in half. This experiment could be used to inform the public about the safest chlorine exposure time for hair.

### **The Effect of Aging on the Sugar Content of Different Fruits**

*Ankita Mandal, George H. Moody Middle School*

Nothing can really match the feeling of eating a fruit when it is “perfectly” ripe. Ripeness brings out the prime flavor, texture, and aroma of a fruit. However, if one was to eat the same fruit a week before or after the peak time of ripeness, the experience would be entirely different. The purpose of this experiment was to see how ripeness affected the sugar content of different fruits, to find the point at which each seemed most enjoyable, and to see how results differed from fruit to fruit. The hypothesis for this project was as follows: if three types of fruit are given a time span of seven days to ripen, then they will contain the highest sugar content on the seventh day. The “optimal” flavor was thought to be found before the fruit over-ripens. To conduct the experiment, ten equal pieces of bananas, strawberries, and grapes were tested every day for their sugar content. This was done with the use of a refractometer in the measurement unit of Brix (°Bx). After doing this, all results were put in graphs and tables and interpreted further. From the data, the sugar content of all of the fruits constantly increased. At times, the margins would be big, while other times, they would be relatively lower. The grapes became the sweetest, the bananas scored the second sweetest, and the strawberries were the least sweet. The increase in sugar for the strawberries was also lower than both the grapes and bananas. Different levels of sweetness in the three fruits made them more appealing for consumption. In conclusion, the fruits all became sweeter, and the points at which they were most enjoyable were all different. The rates of ripeness did not adhere to a single pattern as each fruit did not mature the same way. All in all, this project displayed useful concepts that can be used in the future.

### **The Effect of Different Colors of Hair Dye on the Color Values of Dyed Hair Before and After Sulfate Shampoo Wash**

*Owen Marcus, Sabot at Stony Point*

The business of hair care products is a huge, billion-dollar industry. This industry includes hair dye, a substance that can dye hair a certain color. Hair color dye can insert certain pigments in hair to dye it the color of choice. The problem with the dye is that when washing hair with shampoo, the color will wash out of the hair. However, some colors of dye wash out more than others. Finding the color of dye that would be most effective in hair would be useful information to people who use hair dye on a regular basis. Therefore, the purpose of this experiment was to determine which color of hair dye can hold its color best in hair after being washed several times. In this experiment, the data was collected by finding the color values in hair before and after the hair was shampooed. The hair was measured in two different color models, the RGB (red, green, blue) and the HSB model (hue, saturation, and brightness) which are both different ways to measure color. Red, blue, green, and purple hair dye were used to color hair. The colored hair was shampooed 3 times and re-measured for color values after each wash. The key results of this project showed that the blue hair dye is the most effective color to use in hair. This is because it retained its saturation and brightness values, meaning the color remained in hair better. The other dye colors were not as effective as the blue because they lost value in brightness and saturation, therefore having more color wash out. The blue dye was the most effective, the purple dye was the next most effective, then the green dye, and the least effective was the red dye.

## **Chemical Science B**

### **The Effect of Fertilizer with Different Leading Chemicals on Water pH**

*Tessa Muldowney, Thomas Jefferson Middle School*

The purpose of this study was to identify a type of fertilizer that kept the pH level of water the same. The independent variable was the type of fertilizer. The experimental group included fertilizer with mainly nitrogen and fertilizer with mainly phosphorus. The cups containing no fertilizer were the control group. The pH level of the water over a period of time was the dependent variable. Some constants included the amount of water, type of water, amount of fertilizer, and the duration of the experiment. The hypothesis was: If two different types of fertilizers are tested, then the fertilizer with mainly nitrogen in it will keep the pH the closest to a neutral (7 on the pH scale). Three groups of five cups were filled with water and different types of fertilizer, fertilizer containing mostly nitrogen and fertilizer containing mostly phosphorus. The cups were stirred, and every three days for fifteen days, the pH was tested. The pH was tested with a pH testing kit that included a color chart and pH solution. The results showed that water without phosphorus or nitrogen in it kept the pH level of the water closest to neutral. These results rejected the hypothesis. There was a very small range of data. Regarding the cups containing fertilizer, nitrogen and phosphorus have very similar effects to nutrient pollution. They both create algal blooms and dead zones. Because of that, this might be why the chemicals and their effects on pH may be the same. In conclusion, the study suggests that fertilizers containing mainly nitrogen had the largest change in pH. Its pH was 8 the entire length of the experiment. Because of the small range in data, it can be concluded that nitrogen and phosphorus have similar effects on the pH of water. To apply this study to practical use, it appears that neither fertilizer is better for the environment, as they had very similar

effects. The best way to decrease nutrient pollution and change in pH is to use less fertilizer.

### **The Effect of Adding Different Materials to Ice on How Fast the Ice Melts**

*Zoe Nagle, Swanson Middle School*

In the winter, people around the world use salt and other substances to melt ice that is occupying the roads and sidewalks. This ice is keeping them from engaging in daily activities such as going to school or work. The purpose of this experiment was to determine the most effective way to melt ice quickly. There were three independent variable levels which included ice by itself, ice with sugar and ice with salt. It was hypothesized that the ice with salt would melt the fastest due to salt being one of the most common materials used in the winter to melt ice that is found on roads and sidewalks. This process would be simulated by measuring 10 grams of salt and 10 grams of sugar. Then, each would be placed in separate bowls and one more bowl would have nothing. Then an ice cube would be placed in each bowl and timers would be started and the ice cubes would be watched until completely melted. The ice with salt melted the quickest with an average 2,107.37 seconds. The ice alone melted with an average 3,587.62 seconds. Finally, the ice with sugar melted with an average of 3,863.81 seconds. The light bulb could have given off different amounts of thermal energy affecting the results. As this experiment demonstrated, salt continues to be solution for melting the ice in the winter.

### **The Effect of Different Types of Food Wrap on the Decrease of Moisture Levels in White Bread**

*Sarah Newman, Swanson Middle School*

The experiment conducted was to determine which type food wrap has the lowest moisture decrease in white wonder bread. The purpose of this is experiment is to determine how to keep bread from going stale because 30 to 40 percent of food in America goes unused and is wasted. 27 percent of that food waste comes from grain products. The hypothesis of the experiment was that if the type of food wrap affects the mass over time (moisture loss) of white bread, then the moisture loss over time will be least at tinfoil it creates a barrier to air, moisture, and light. The experiment was conducted 10 times for each independent variable level. The independent variable levels were plastic wrap, aluminum foil, wax paper. The control of the experiment was no wrap. Each piece of bread was labeled, weighed, and then placed in the center of its respected food wrap. Then the wrapped bread was set on trays and sat for 6 days in the same room. After those 6 days the bread was unwrapped and reweighed. The results showed that bread wrapped in aluminum foil had the least amount of moisture lost (1.2 grams) and the bread wrapped in plastic wrap had the third most amount of moisture loss (5.5 grams). The bread wrapped in wax paper had the second greatest moisture loss (7.4 grams). The control of no wrap had the greatest moisture loss (9.5grams). Grain products harden when starch undergoes crystallization or starch retrogradation. In conclusion wrapping bread in aluminum foil would save massive amounts of bread because bread would not undergo retrogradation and harden at such a rapid rate and the bread would not be thrown away and wasted.

### **How Does Pizza Box Protectants Affect Stain Depth and Stain Area?**

*Robert Overstreet, Sabot at Stony Point*

This experiment was done to see what could be done to decrease the amount of pollution that comes when pizza boxes are unrecyclable, causing many more trees to be cut down. The experimental approach was to test “protectants” to cover the inside of the pizza box and make it so the pizza box could be recyclable by blocking the fat and oil that usually makes the pizza box unrecyclable. The tests were performed by letting fat and oil set on a pizza box and seeing how much soaked through protectants onto the cardboard, if the fat and oil soaked through. Stain depth and overall area were charted down and graphed as results. The results of the experiment were that out of the three protectants used in the experiment, two of the protectants, tin foil and parchment paper, effectively blocked fat and oil. The wax paper didn’t effectively block oil. The major results and conclusions for this project was that parchment paper and tinfoil where the better protectants over the other protectant, wax paper, as shown by having no fat and oil soaked through the protectant onto the tin foil and parchment paper. This would mean the hypothesis of tinfoil being the best protectant was supported. There could be further tests done to show what protectant out of the two could be the best at protecting boxes from fat and oil.

**The Effect of Baking Soda on the Rate of Electrolysis in Water**

*Aaditi Parab, George H. Moody Middle School*

One of the ways hydrogen gas is produced is through electrolysis. Electrolysis is a process in which an electrical current is applied to a liquid compound to separate it into its original elements. When an electric current is applied to water, it separates into hydrogen and oxygen. As hydrogen is a gas with many uses, generating hydrogen through electrolysis needs to be more energy efficient. Electrolytes can be added to water to speed up electrolysis. The purpose of this experiment was to determine the effect of different amounts of baking soda, 0, 3, 6, 9, and 12 teaspoons on the rate of electrolysis in 900 mL of water. To test this, two test tubes were marked in the same place and placed inside a beaker filled with 900 mL of water. Two wires were attached to a battery and the other ends were placed inside the two test tubes. The amount of time taken for gas to reach the mark on the test tube that was attached to the negative side of the battery was measured. The different amounts of baking soda were added to the water and tested. Each level of the variable was tested 10 times. The results indicated that the water with the greatest amount of baking soda was the quickest to electrolyze with a mean time of 11.53 minutes. The water with the least amount of baking soda was slowest to electrolyze with a mean time of over 90 minutes. The data collected supported the research hypothesis that if 0, 3, 6, 9, and 12 teaspoons of baking soda are dissolved in water, then the time taken for the water to electrolyze will be greater for water with 0 teaspoons of baking soda and less for water with 12 teaspoons of baking soda. Based on the research in this project, there is a relationship between the amount of baking soda in water and time it takes for the water to electrolyze.

**The Effect of Ambient Air Temperature on Ice Melt in Salt Versus Fresh Water**

*Owen Parker, Sabot at Stony Point*

By 2100, sea levels are predicted to rise by three feet. This is partially caused by glacier melt. This experiment looked at the rate of ice melt in three different ambient air temperatures by comparing the rate of ice melt in salt versus freshwater at 3 degrees, 11 degrees, and 20 degrees Celsius. The average difference between the remaining ice

mass at one hour in salt versus freshwater at the three temperatures was used to compare the rate of ice melt across the six conditions. The results showed that the average difference of remaining ice mass was 87.4 grams at 3 degrees Celsius, -1.4 grams at 11 degrees Celsius, and -15.9 grams at 20 degrees Celsius. This suggests that in colder air temperatures, ice melts slower in saltwater than in freshwater, but at warmer temperatures, ice melts faster in saltwater. However, a box and whisker plot was constructed and showed that the differences were not statistically significant due to the overlap of the interquartile ranges.

### **The Effect of Humidity on the Thickness of Wood**

*Timothy Porter, George H. Moody Middle School*

Humidity (the concentration of water vapor in the air), the independent variable of this experiment, is an integral part of the air around us. It affects many different aspects of life on Earth. Similarly, wood is an important part of everyday life for most people, as it is used in many everyday items. As an organic material, it can be affected by humidity. So, this experiment aims to find this effect, specifically how humidity changes the wood's thickness. As such, the hypothesis is as follows: "If the humidity is set to 80% around wood for 3 hours, the thickness will increase by about 1% of the wood's original thickness." The procedure to conduct the experiment was fairly simple. Ten pieces of wood were placed in a controlled environment of 22°C three separate times. The first with a relative humidity (RH) of 35%, then with 50%, then with 80%. Each time, measurements of the wood's thickness were taken and recorded (in millimeters) using a caliper. A humidifier or dehumidifier was used (if necessary) to reach the required humidity. The results of the experiment are shown in a bar graph to the right. The mean growth from 35% to 80% was a .18% increase in thickness. These results show that a higher humidity causes the wood to swell. This increases the size of the wood overall. If this experiment were to be repeated, more trials should be conducted to reach higher statistical significance, and larger wood should be used to increase the changes in thickness and allow more accurate measurements.

### **The Effect of Different Types of Flours on the Density of Cupcake**

*Nithyasai Ravula, George H. Moody Middle School*

Cakes and other baked goods are made with many different ingredients, including flour, butter, milk, sugar, eggs, and a leavening agent. Flour is one of the most important and most used ingredients in any baked product. Flour is a gluten product made from wheat that provides the structure to a baked treat. Too much flour results in a dry cake and too less results in a gooey cupcake. The type of flour that is used in a cake or cupcake is important as well. The purpose of this experiment was to find out which kind of flour creates the densest cupcake. The hypothesis was if cake flour was used, then the cupcakes would be the densest. This experiment was performed by baking four groups of 6 cupcakes. Each group was made using a different type of flour. The four types of flour used were all-purpose flour, self-rising flour, whole-wheat flour, and cake flour. After the cupcakes were made the densities were found for each of the six cupcakes in each level and the average was found. The results yielded were really close in number. The mean density of the all-purpose flour was 0.74 g/cm<sup>3</sup>. The mean density for the self-rising flour was 0.75 g/cm<sup>3</sup>. The mean density for the cake flour was 0.6 g/cm<sup>3</sup> and the mean

density for the whole-wheat flour was  $0.64 \text{ g/cm}^3$ . If this project would be done again, some changes that would be made would include making precise measurements of the ingredients, allowing the batter and the cupcakes to have the same amount of rest time, bake time, and cooling time. If this experiment was done again in the future for further researcher, some topics to be explored could be the best type of sugar to use, whether to use baking soda or baking powder, whether to use butter, shortening, or margarine, and whether to use egg yolks, egg whites, or the whole egg. When the results to these experiments are found, the perfect cupcake can be made. As a conclusion of the experiment, self-rising flour is the best flour to use when a dense cupcake is the desired outcome.

### **Heartburn Helpers**

*Sofia Reyes, Swanson Middle School*

The goal of my experiment was to see which heartburn medication got to a pH of 7 after being left in a fake stomach acid solution for six hours. My hypothesis if the heartburn medication is changed, then the stomach acid's pH will be raised the most by the Licorice Root. I came to this conclusion because the therapeutic research staff of WebMD say that a natural remedy is healthier and more beneficial for you than PPI's (proton pump inhibitors), antacids, and/or H2 blockers. I choose this independent variable out of the other ones because natural solutions for things are said to work just as much or better than normal medications. However, my hypothesis wasn't supported. The heartburn medication that reached a pH of 7 was the antacid. The brand of antacid I was using has been around for a long time and had lots of time to perfect their recipe. Another reason their product may have worked the best is their natural ingredients. Calcium Carbonate is in 4% of the earth's crust and is found in many stones. Mineral oil is in every one of their products too. The majority of the Tums medicine is natural. This could be a factor in the medication performing well or not.

### **The Effect of pH on the Rate of Corrosion**

*Chris Robles and Joseph Sparks, Gunston Middle School*

### **The Effect of Wood Type on Energy Released During Combustion**

*Abel Rudolph, Sabot at Stony Point*

Wood is a scarce resource that is extremely necessary for people who need it for warmth or for cooking. This paper studies the best type of tree to plant in order to have a supply of wood with the highest energy content. The purpose of this experiment was to discover which kind of wood releases the most amount of energy when burned. The types of wood burned for this experiment were walnut wood, birch wood, cherry wood, maple wood, and oak wood. The study measured the amount of heat each type of wood released when burned. This was measured by using a home-made calorimeter. The study included five trials for each of the five types of wood. The hypothesis was that the birch wood would release the most amount of energy when burned because of its density and hardness. The data did not support the hypothesis and instead showed that walnut wood released more energy than the other types of wood, however, the differences in the amount of energy released were not significant. The average calories for oak wood was 1.003 Kcal;

for birch wood it was 0.957 Kcal; for walnut wood it was 1.029 Kcal; for maple it was 0.454 Kcal; and for cherry it was 0.669 Kcal.

### **The Effect of Different Types of Salts on the Boiling Point of Water**

*Rishav Sen, George H. Moody Middle School*

Humans have been boiling water for centuries, yet not much research has been done on how to change it. There are many uses for hot or warm water not boiling, like for cooking or hot tubs. A study was done to change the boiling point of water with different salt-water solutions and the hypothesis was, "If sodium chloride is dissolved into water, it would raise the boiling point of water the most". The salts used were sodium chloride, magnesium sulfate, and sodium bicarbonate. Each of these salts were boiled in 100mL of water at three concentrations. They were 2.5g/100mL, 5g/100mL, and 7.5g/100mL and they were each tested four times. The results showed that sodium bicarbonate increased the boiling point the most. Therefore, the hypothesis was rejected, and the null hypothesis was also rejected. This may have been so, because it breaks down into sodium hydroxide and carbon dioxide which might have heated up the water.

### **The Effect of Different Cold Medications on the Rate of Dissolution**

*Kaleb Sisay, Thomas Jefferson Middle School*

The purpose of this study was to research the effect of different cold tablet medications on the rate of dissolution. The independent variable was cold and flu tablet medications. The experimental group included these brands: Advil, Alka-Seltzer, Tylenol, Coldcalm, NyQuil Cold & Flu Acetaminophen. There was no control group. The dependent variable was the rate of dissolution. The constants were; the type of acid used to dissolve the tablets (hydrochloric acid), number of tablets per medication tested, and the environment surrounding the lab area. The hypothesis was: If different cold and flu tablet medications are dissolved in a simulated stomach, then the Advil medication will take the longest to dissolve. 5 tablets of each brand were placed in HC1 until they dissolved. Then the time measurements were used to create a bar graph. The results showed that Tylenol took the longest to dissolve. These results rejected the hypothesis. In conclusion, the study suggests that tablet's that have thicker coatings have a slower dissolution.

### **The Effect of Different Sports Drinks on the Amounts of Electrolytes and Sugar Consumed**

*Jordanna Silverman, George H. Moody Middle School*

Electrolytes are a necessary chemical that athletes consume before or after a workout. These chemicals help regulate muscle function, provide hydration for the body, and help rebuild tissue that was damaged during a workout. A lack of electrolytes in the body can cause muscle weakness and contractions. Electrolytes are lost through sweat during exercise, so in order to regain the lost electrolytes, athletes drink liquids rich in electrolytes. Many of these drinks also contain a high amount of sugar. The sugar gives athletes some of the energy to complete their workout but not is not good for their health. This experiment's purpose was to determine the conductance of various sports drinks. Additionally, the amount of sugar in each of these drinks was measured and recorded. All of this data was then gathered and compared to determine which drink is the best for athletes to drink. In order to complete this experiment, the conductance sensor was assembled. Next, the containers with each drink were set out and labeled. Then the

conductance sensor was placed into the liquid, and the information was measured and recorded. The experiment has five trials to ensure accuracy in the results. The conductance sensor measured the current, so after the experiment was complete, the data was put into the equation  $G=I/V$  to calculate the conductance. Based off of the data from the experiment, the drink with the highest concentration of electrolytes was Grape Pedialyte, but it was one of the drinks with the highest amount of sugar. The drink with the highest amount of sugar was Coca-Cola and this drink had one of the lowest conductance. The experiment could have been improved by adding additional experiments which measured the effectiveness of the drinks during a workout. This would then be compared to the amount of sugar and electrolyte concentration of the drinks to provide more information about whether or not the drinks are good for athletes.

### **The Effect of Borax on the Height a Ball Bounces**

*Katherine Snelbecker, Williamsburg Middle School*

This experiment studies the link between the amount of borax and the height a ball will bounce. The objective was to find the amount of borax correlated with the highest bounce height. The hypothesis was that more borax is correlated to a higher bounce height. The levels of independent variable (IV) were 2.16, 4.34, 6.49, and 8.65 grams of borax, and the mean bounce height was 1.8, 3.2, 12.5, and 8.2 cm respectively. The lowest borax amount trial had the lowest bounce height; the second lowest borax amount trial had the second lowest bounce height; the third lowest borax amount trial had the highest bounce height; and the highest borax amount trial had the second highest bounce height. The experiment results generally supported the hypothesis.

### **The Effect of Different Temperature on the Caffeine Content of the Coffee**

*Sreebals Sreekesh, George H. Moody Middle School*

Caffeine research is becoming more popular. Caffeine is becoming a more popular stimulant to humans and has an impact of everyday life. People get caffeine in a variety of different forms, styles, brews, roasts, et cetera. The purpose of this experiment is to find out whether different temperatures had an effect on the caffeine content of coffee. The hypothesis was that if the temperature of the coffee decreases, then the amount of caffeine will increase. To conduct the experiment, solvents were made including ethyl acetate which acted as a separating agent and calcium chloride and magnesium sulfate which were both drying agents. After forming a solvent and adding it to coffee of different temperatures, they were boiled off until only distilled coffee remained. After 12 trials were performed for each level of independent variable, data was collected and graphed. The data showed that more substance was collected as the temperature decreased although the control, a regular hot-brew coffee, had a quantity of substance that fell in between the levels of IV. Overall, the hypothesis was not fully supported by the experiment although may be backed up by similar studies and research. Whether different temperatures had an effect of the amount of caffeine in coffee is not completely clarified by the experiment as hypothesis lacked support from the data.

### **The Effect of Different NSAID's on its Rate of Dissolution**

*Arya Suram, George H. Moody Middle School*

Nonsteroidal anti-inflammatory drugs have been around for a while and come in many forms from over the counter to prescription drugs. On a very simple level, these drugs



can sense where pain occurs and act upon it efficiently by reducing inflammation and any swelling that occurs near the pain point. However, a very common question is normally asked when associated with different NSAID's: which one is the best? And, this question can be interpreted in multiple ways. "The best" can mean which one has the greatest effect? How long does will a tablet take to dissolve? I, however, interpret it as, which NSAID tablet will dissolve the most in a set amount of time in a glass of water? This can tell us which tablet dissolves the most, in some cases which one dissolves faster, and which one to use to aid pains quickly. Through some preliminary research, I have figured out that Ibuprofen is one of the most commonly used NSAID tablets that is found in many households. I started to wonder whether or not this pill was used for its popularity or if there was actually any proof that it was the greatest to use. If Ibuprofen is applied to a glass of water, then the percent of the Ibuprofen tablet left will be the least out of the rest of the levels. In order to test this hypothesis, each tablet was placed in a cup of water and stirred at specific point in time to replicate the digesting and full use of the tablet. The results were then strained and observed to see if there was any tablet residue or excess, undissolved pills in general. This was repeated for each level ten times. The results showed that Advil and Bayer were the two candidates that were fully dissolved in water. A bar graph was created to show the results of each level and the amount of tablet that was dissolved. These results then told me which tablets were the best to use when wanting fast relief from minor aches and pains.

### **The Effect of the pH of Different Substances on the Corrosion of Iron**

*Annabel Tang, George H. Moody Middle School*

In 2016, the National Association of Colleges and Employers released a study in which it estimated the global cost of corrosion to be 2.5 trillion US dollars, roughly 3.4 percent of the total global gross domestic product. Iron and products consisting of iron are used across the world in the construction of buildings, bridges, cars, and an enormous number of other objects, but are often degraded and even destroyed in the process of corrosion, in which a gas or liquid chemically attacks an exposed surface. Corrosion breaks down the material of an object, typically a metal, which can then cause the reinforcing in objects like concrete to fail, resulting in the collapse of electrical towers, buildings, and bridges. Additionally, as the environmental problems of rain with low acidity, or acid rain, becomes a greater issue, this breakdown of metals is consistently a larger threat. The purpose of this experiment was to test the effect of solutions of different pH's on the post weight and overall corrosion of iron nails. Iron nails were placed inside test tubes filled with various solutions. Each solution consisted of vinegar and/or water diluted to different pH's (2.3, 3.5, 4.7, 5.9, 7). The iron nails were then left in the test tubes for 144 hours, the corrosion process was observed, and the subsequent weight loss was recorded. The data indicated that, as the pH of the solution decreased, the average post weights of the nails decreased and the amount of visible rust on the nail increased. A one-way analysis of variance test performed on the data indicated a significant difference between the treatments ( $p=0.03906$  at  $p<0.05$  and  $f=2.7589$ ). The data supported the hypothesis that if the solution had a lower pH, then the weight loss and the overall corrosion of the nail would be greater when compared to a solution with a higher pH. Consequently, based on the weights of the iron nails collected, there was a direct correlation between the pH of a substance and its ability to corrode iron.

## **Nutritious, or Just Delicious?**

*Alena Topchy, Swanson Middle School*

The purpose of this experiment was to discover if cooking fruits reduces the amount of vitamin C the fruit contains. Six fruits were tested using a cornstarch and iodine solution. The lighter the solution got after adding the fruit, the more vitamin C it contained. A rating chart was used to determine this. In five out of six fruits tested, the uncooked fruit contained more vitamin C than the cooked fruit. The sixth fruit tested had the same result for both cooked and uncooked. So overall, from this experiment, it appears that cooking fruits reduces the amount of vitamin C it contains.

## **The Effect of Wheat Flour Type on Gluten Content**

*Julia Wall, George H. Moody Middle School*

Flour and wheat have been a staple of our diet for thousands of years. Flour is finely milled wheat or other grains that is primarily used for baking. Gluten is the general name for the 70 different “storage” proteins of wheat. Gluten determines the dough quality of bread and other baked goods. It is used as a binding and extending agent and helps baked goods rise. Although the vast majority of Americans eat gluten on a regular basis, 23.6 million Americans have gluten/wheat-related health issues. The percentage of people with these health issues is rapidly increasing, so it is important to find out more about wheat, gluten, and their relationship with the human body. The purpose of this experiment was to identify the gluten content in different types of wheat flour. For the experiment ten trials of six different wheat flours were tested for gluten content using a gluten separating method by rinsing balls of flour with water. The remains of each ball of flour was measured in grams. It was hypothesized that “If bread flour is tested for gluten content, then it will contain the most gluten.” The ten trials for each flour were averaged and put into multiple graphs for further analysis. The averages for each flour were found to be as follows, whole-wheat flour: 58.8 grams, all-purpose flour: 42.8 grams, bread flour: 55.4 grams, cake flour: 34.3 grams, pastry flour: 15.3 grams, and gluten-free flour: 0 grams. In conclusion, it was found that the hypothesis was not supported by the data collected. Whole-wheat flour was found to contain the most gluten, not bread flour. While uncontrolled variables could have affected the outcome of this experiment, the results seem to reflect the findings of others. Overall, this experiment was a fascinating look at the world of flour, gluten, and how scientists are working to solve the problem of gluten/wheat related health issues.

## **The Effect of Different Temperature on the Amount of Pineapple Enzyme Activity Based on the Amount of Jello Dissolved**

*Monona Zhou, George H. Moody Middle School*

Temperature was the amount of average kinetic energy in the particles of a substance. Enzymes were a type of catalysts that helped reactions. In a pineapple, there were several types of enzymes, one example was bromelain enzyme. Whenever bromelain enzymes touch jello, the jello would begin to liquefy. This was because the enzyme molecules took the jello molecules and caused a reaction to happen, which made the jello liquefy. The purpose of this experiment was to see how much impact temperature had on the amount of pineapple enzyme activity. The hypothesis for this experiment was if a cube of pineapple was set at 50 degrees Celsius, then the enzyme activity would be the highest. The procedure was to cut the pineapples into cubes, incubate them at different

temperatures, the independent variable levels, place them on a jello cube, and then measure the amount of liquefied jello there was after. The results were that the 0 degrees Celsius independent variable level had no enzyme activity and had 0 mL of liquefied jello. The 25 degrees Celsius level had a bit more of enzyme activity with an average of .72 mL of liquid jello. The 50 degrees Celsius level had more activity and had an average of 8.45 mL of liquid jello. The 75 degrees Celsius level had the most amount of enzyme activity with an average of 12.8 mL of liquid jello. 100 degrees Celsius level had less activity and an average of 7.18 mL of liquefied jello. The conclusion was as the temperature increases from 0 degrees Celsius to 75 degrees Celsius, the amount of pineapple enzyme activity increased. However, some of the enzymes had begun to burn when set at 100 degrees Celsius which caused less activity to happen. In research conducted by other experimenters, it was found that similar types of enzymes showed the same reaction when affected by temperature.

## **Chemistry**

### **The Effect of Gold Nanoparticle Concentration on the Photothermal Energy Conversion Efficiency**

*Joshua Alexander, Deep Run High School*

In chemistry, gold nanoparticles or colloidal gold nanoparticles have a variety of uses. One of the unique properties of gold nanoparticles is its ability to interact with visible light known as surface plasmon resonance. The surface plasmon resonance of gold nanoparticles causes the electromagnetic fields to strengthen allowing it to generate heat. Since the peak absorption wavelength of light of gold nanoparticles is close to the wavelength of sunlight, it makes them an excellent candidate for photothermal energy conversion. Some of the photothermal conversion processes including steam generation and solar water desalination have become a prominent solution to widespread water scarcity and lack of access to clean drinking water in remote areas of the world. For this particular experiment, a scale and petri dish with various gold nanoparticle concentrations were placed underneath a solar simulator to determine their photothermal energy conversion efficiencies. The hypothesis for this experiment was if 1.0 mM gold nanoparticle (Au NPs) concentration is used, then it will have the greatest efficiency. The weight and temperature of the solution were recorded for 30 minutes at 5-minute intervals. The research hypothesis was supported by the data collected from this experiment because the 1.0 mM Au NPs had the greatest efficiency of 42.00% and the null hypothesis was rejected ( $t = 1.456 > 1.330$  at  $df = 18$ ;  $p > 0.20$ ), therefore the data was proven to be significant from the control group of DI Water. In conclusion, an effective gold nanoparticle concentration was found with the highest photothermal energy conversion efficiency.

### **The Effect of Filtration Material on Lead Concentration**

*Natalie Aramendia and Lillian Watson, Washington-Lee High School*

The purpose of this project was to investigate the filtration capabilities of fruit peels. The independent variable was the filtration material and the dependent variable was the lead concentration. The hypothesis stated that if fruit peels are used as a filtration material, then the lead concentration of the water would be reduced because of the attraction between the functional groups on the peels and the lead ions. All three peels tested, apple, banana, and orange peels were effective in reducing lead concentration; however,

orange peels were the most effective. The orange peels were able to reduce water with a lead concentration of 400 ppm down to 39.0 ppm on average. Banana and apple peels, on the other hand, reduced the lead concentration from 400 ppm to 230 and 280 ppm, respectively. Comparatively, the manufactured carbon filter removed all detectable levels of lead. Based on these results, carbon filters are ideal for filtering high levels lead from water, however, if unavailable, fruit peels are a viable second option.

### **The Simultaneous Corrosive Effects of Atmospheric Pollutants**

*Ryan Berry, Thomas Jefferson High School for Science & Technology*

Corrosion is a chemical process in which a metal is changed to an oxide of the original metal, and it basically causes iron to be broken down and destroyed. Although we know that environmental pollutants can exacerbate the extent of corrosion on metal, we know much less about the influence of simultaneous chemical processes on corrosion. This project explores both the theoretical and empirical effects of different levels of simultaneous environmental pollutants across five regions in the US on the corrosion of iron rebar to better understand and predict detrimental effects of corrosion on bridges and other metal infrastructure across these five regions in the US. The author analyzed the theoretical differences that environmental pollutants have on corrosion, focusing on sulfuric acid and chloride. This analysis showed the difficulty of predicting which region would produce the most corrosion because while chloride speeds up the electrochemical process, the rate cannot be predicted. The author then used data from the Environmental Protection Agency (EPA) to make water-based mixtures that represent the atmospheric conditions across five regions in the US, with chemicals at 10x the original concentration levels to accelerate corrosion. A ten-week simulation was carried out by spraying the concentrations on iron rebar twice a day. The results were examined by visual observation, from scanning electron microscopy (SEM) images to explore the depth of corrosion, and from weight loss (examining pre and post corrosion weights). The results reveal visual and SEM differences in corrosion across these five regions, which highlight the importance of experimental analyses to understand interactions. Overall, the results suggest that a mix of predicting and experimenting is likely to produce the best results when trying to monitor the corrosion of the metal-based infrastructure across different locations in the US and to avoid bridge collapses.

### **Effects of Various Types and Concentrations of Solutes on Passive Daytime Radiative Cooling in Paint**

*Yiming Chen, Yorktown High School*

Overheating of buildings has long been a global problem. It poses severe health threats in developing countries and induces ozone depletion where air conditioning is prevalent. Passive daytime radiative cooling (PDRC) in paint serves to combat this problem by spontaneously reflecting light and emitting heat off the surface. White paint is the simplest PDRC material. My project serves to test the effects of acetone, ethanol, and ethyl acetate on the PDRC qualities of white household acrylic paint when they are added in higher and lower concentrations along with water. I performed six trials with concentrations of approximately 6% and 25% of each solute by mass. A pure white paint sample serves as the control. Setting up a light bulb to mimic sunlight while keeping the distance of exposure and area of data collection constant, I used a surface temperature sensor to collect data over time. Statistical analysis with a z-score test proved all trials to be

significant, though increasing concentration did not show a trend of increasing PDRC effectiveness. Using Lewis structures for all species involved and applying knowledge of van der Waals forces, I analyzed the differences in PDRC effectiveness for each trial. The findings in this experiment are impactful as they provide an approachable and affordable method to reduce surface temperatures of white paint by a maximum of 3.4°C. Determining an optimal low concentration of solute can allow for large scale implementation, resulting in an adequate solution to the aforementioned problems.

### **The Effect of Cleaning Agent on the Reversal of Environmental Exposure in Aluminum Fences**

*Sarah Coffman, Mills E. Godwin High School*

The purpose of the experiment conducted was to determine the effects of cleaning agent on the restoration of aluminum fencing. Through the completion of this experiment, said individuals could save money by effectively cleaning fences, rather than wasting money on needless replacements. The results of this experiment could also help homeowners to have a more appealing exterior. Environmental exposure can cause aluminum fencing patina or develop a brown film on the surface. By using various cleaners to remove this film, the aluminum can return to a glossy finish, meaning a higher the gloss reading and a better restoration of the fence. The reversal of environmental exposure in aluminum fencing, was measured with a Gloss meter in GU, which can also be shown as Ga, units, gloss, or gloss units, at an angle of incidence of 60 degrees. This was done by exposing aluminum fencing to the outside environment for a period of two years, cleaning the fence with solutions containing baking soda, vinegar, or dish soap, then measuring the resulting gloss and interpreting the data. It was determined that cleaning with vinegar resulted in the greatest reversal of environment exposure, as it had the greatest Ga, supporting the research hypothesis. A t test was performed, and it was found that the data was significant for each of the levels of the independent variable. It is believed that the results found are due to the fact that vinegar has the most acidic properties, and therefore would corrode the fence coating to restore the fence to its previously glossy state. The research conducted could be improved by increasing the sample size of each cleaning agent and extended with the addition of other popular cleaning methods, or by testing cleaning agent on other types of fencing.

### **The Effect of pH on the Amount of Glucose Produced when using Lactase over Time**

*Grace Franklin and Megan Peck, Washington-Lee High School*

Lactose intolerance affects most of the world, this is due to the lack of an enzyme called lactase. Without lactase, humans couldn't process lactose which is in dairy products. The purpose of this experiment was to see the effect of different pHs on the amount of glucose produced when using lactase over time. Lactase is an enzyme that converts lactose into glucose. Varying pHs can have major impacts on the effectiveness of enzymes, because the enzyme may not be able to fully activate which could lower the glucose levels. The hypothesis stated that if acids and bases are added to milk with lactase over time, then the acidic trial (5.5) will create the most glucose because it is closest to the ideal pH. Solutions were created with varying acidities of 4.5, 5.5, 6.5 and 8.5. Lactase was then added to the solutions and over time the amount of glucose in each solution was tested

using glucose strips. All of the groups were statistically significant. The results supported that the optimum pH for the enzyme lactase was most effective and yielded the greatest amounts of glucose. The results followed the pattern of a bell curve with the peak of the curve at the optimum pH and decreased down from the peak on both sides for the basic and acidic solutions. This shows that it is very important for the pH's to be controlled in order for the lactase to convert the most lactose to glucose possible.

### **The Effect of Adding Different Substances to Gelatin on the Gel Strength and Solid Shape of Gelatin**

*Samantha Graham, Clover Hill High School*

### **Behavior of Gases in Contact with Liquid Nitrogen**

*Ellen Habteyonas and Dasol Lee, Blacksburg High School*

In the chemistry field, although practical knowledge on non-ideal gas behavior is very limited, continuing research has been conducted to improve accuracy in the use of gases at extreme temperatures versus how they are used currently. A common demonstration currently used to demonstrate Charles' Law behavior, the direct relationship between volume and temperature, is submerging an air-filled balloon in liquid nitrogen. The balloon is expected to collapse in on itself when submerged and then return to its original size when removed. After doing further research, we realized that very little other experiments had been conducted to compare how different gasses would behave at the same extreme temperatures, and to what degree their characteristics would influence the rate of their behaviors. This research replicates the common Charles' Law demonstration, however using oxygen (O<sub>2</sub>), helium (He), and sulfur hexafluoride (SF<sub>6</sub>). Based on the higher thermal conductivity of liquid nitrogen versus the air, all gases would be expected to deflate faster than they inflated. Helium however, behaved in reverse, while both oxygen and sulfur hexafluoride behaved as expected. The intermolecular forces, molecular weight, melting points, and thermal conductivities were assessed in determining the reason of helium's behavior. This shows that gases behaviors at extreme temperatures cannot be generalized and need to be studied individually. Advances in knowledge of behaviors of a range of gases at severely cold temperatures will improve precision in developing fields such as cryogenics. Cryogenics deals with the production, effects, and uses of a wide variety of materials at very low temperatures, which is now beginning to expand to more complex beings.

### **The Fate and Transport of Triclosan in Treated Effluent of Rural Receiving Streams**

*Isabel Hendrix, Southwest Virginia Governor's School*

One of the major issues in the current wastewater industry is the issue of emerging contaminants. These contaminants present an issue for treatment plants because it is almost impossible for them to be removed by traditional means, as they often make way into the environment, and have the possibility to be an environmental concern. The most common of these contaminants is triclosan, as an estimated 100 million metric tons of triclosan wash down American drains every year. Triclosan was the substance that the researcher chose to examine in the present study, and specifically examined how triclosan distributes in the receiving stream of wastewater treatment plants. The researcher did this by collecting samples from four locations along and around the

receiving stream of a small wastewater treatment plant and analyzing them using Liquid Chromatography-Mass Spectrometry. The study revealed inconclusive results, as the triclosan levels in the sample were below the detection level of the instrument used, which is 1 ppm. Although the data was inconclusive, further research can be done using Solid Phase Extraction to find the exact concentration of samples. This would provide more conclusive results, from which more useful conclusions could be drawn.

### **Analysis of Nitrogen Compound Concentrations in the Lower Western Chesapeake Bay**

*William Hutcheson, Chesapeake Bay Governor's School for Marine & Environmental Science*

One of the major nutrients that influences eutrophication is nitrogen. Nitrogen (N) can enter the water column as many different compounds. To assess the nitrogen levels in the coastal waters of Mathews County, 8 sample sites were tested for nitrate (NO<sub>3</sub>-), nitrite (NO<sub>2</sub>-), and ammonia (NH<sub>3</sub>). To determine whether nitrogen sources are naturally occurring or caused by human interaction, 4 of the sample sites were selected near agricultural fields, while the remaining 4 were selected in common household areas. A total of 14 samples were taken throughout the study, beginning in July and ending in October. It was found that there is no significant difference in nitrogen levels between agricultural sites and non-agricultural sites for any of the three nitrogen compounds. The study also found that ammonia is the most prevalent of the three nitrogen compounds, while nitrate and nitrite are often untraceable except for occasional spikes. The cause of these spikes can be inferred based on the form of nitrogen compound that is found.

### **The Effect of pH on the Time it Takes for Amylase to Break Down Starch**

*Andrew Murray, Yorktown High School*

### **The Effect of Size of Gadolinium Silicide Nanoparticle on Magnetization**

*Chirayu Nimonkar, Mills E. Godwin High School*

Magnetic nanoparticles for medical applications is an emerging field with the potential to be more effective and yield fewer side effects than conventional treatments. To fully realize the potential of this growing technology, every aspect of the particles must be optimized. This investigation aimed to determine the effects of particle size on the magnetization of gadolinium silicide (Gd<sub>5</sub>Si<sub>4</sub>) nanoparticles. The hypothesis was that if the smallest particles were used, then they would yield the most magnetization. Using timed sedimentation in isopropyl alcohol, the particles were separated into 300, 550, 650, and 750-nanometer particle sizes. Since nanoparticles are not yet standardized, there is no conventional particle size and therefore no control. The magnetization was measured in emu/g and SEM micrographs were taken to confirm the average particle sizes. The 750nm size had the highest average magnetization (0.09380650 emu/g) followed by the 650, 550, and 300-nanometer particles. The observed results did not support the hypothesis as the smallest particle actually yielded the least magnetization (0.00001346363 emu/g). Multiple t-tests showed that each comparison was significant, and therefore particle size has an effect on the magnetization of Gd<sub>5</sub>Si<sub>4</sub> nanoparticles. The findings are different from other research in iron nanoparticles since, unlike iron nanoparticles, the Curie temperature remains constant in different particle sizes of gadolinium silicide. This allowed every atom in the larger particles to stay magnetized,

yielding an overall higher magnetization. To further optimize the nanoparticles, future research in other aspects like particle shape and shifts in Curie temperature would be needed.

### **Determining UVB Radiation Effects on CO<sub>2</sub> Production of *Saccharomyces cerevisiae* with GABAA-rho Supporters**

*Pooja Patel, Mills E. Godwin High School*

This paper illustrated the effects of GABAA-rho neurotransmitter supporter solutions on *Saccharomyces cerevisiae* with exposure to UVB light. Annually, 11 million individuals are diagnosed with forms of retinal-damaged diseases like macular degeneration and cataracts. Thus, the purpose of this experiment was to determine an effective solution in order to prevent retinal-related diseases. The yeast and GABAA-rho neurotransmitter supporters were experimented upon with UVB radiation as a representative model of the human retina. Yeast was added to several solutions of water and GABAA-rho supporters and exposed to UVB light; after 200 seconds, the rate CO<sub>2</sub> production was calculated and analyzed. The research hypothesis formulated stated that if the GABAA-rho neurotransmitter supporters were used, then the yeast would show the greatest rate of CO<sub>2</sub> production with exposure to UVB light. The data results collected supported the research hypothesis as the solution with the neurotransmitter supporters showed the highest rate of CO<sub>2</sub> production. After completing a statistical analysis of t-tests and linear regression test that were compared to the control of yeast and H<sub>2</sub>O, the results revealed that the data was overall statistically significant. With an exception to 2 t-tests performed, the GABAA-rho supporters overall did increase the rate of CO<sub>2</sub> production of yeast. The results were believed to be due to the fact that the UVB radiation produced nitric oxide which aids in the production of GABA neurotransmitters. In addition, the CO<sub>2</sub> production of yeast was found to be directly proportional to GABAs, which was representative of the human retina. With the results of the data, the neurotransmitter supporters could be of benefit to the medical area in terms of preventing retinal-damaged diseases.

### **Testing the Effects of Sodium chloride on Metals used in Exhaust Systems**

*Abigail Pitts, Central Virginia Governor's School for Science & Technology*

The purpose of this study was to determine if there was a difference between the rate that five metals corroded when in the presence of sodium chloride. Five samples were taken from each of the five groups: stainless steel, carbon steel, chrome, aluminum, and galvanized steel. Each sample group was sprayed with a solution of salt water every four to five days for around five weeks. The difference between the final and the initial mass was used to figure out the average percent increase of mass within each group, and those measurements were used when performing a single factor ANOVA test. The test returned a p-value of  $7.74 \times 10^{-12}$ , which, with an alpha of .05, demonstrated a statistically significant difference between the metals. A Tukey Test showed a *Q*<sub>t</sub> value of 4.23 and a *D*<sub>min</sub> of .0662. The difference lay between the following: aluminum (with an average .4082% increase) and stainless steel (.2065%), carbon steel (.05585%), galvanized steel (.09727%), and chrome (.1627%); between stainless steel and carbon and galvanized steel; between chrome and carbon steel. The data did not support the research hypothesis that stainless steel had the best corrosion resistance. However, the study



showed that the type of metal has a statistically significant effect on how quickly it corrodes.

### **The Effect of Various Catalysts on the Rate of Fermentation**

*Sahil Reddy, Mills E. Godwin High School*

### **Reduction of Hydrogen Porosity in Aluminum Welding with Vibratory Methods**

*Kathleen Reuwer, Southwest Virginia Governor's School*

Hydrogen porosity, formed when hydrogen pockets get trapped during the cooling of molten metal, is a dangerous problem faced in welding. The presence of hydrogen porosity causes welds to be unstable and unreliable for consumers. Current instruments, like inverter power sources and spin arch torches, are effective but often cost prohibitive for welders. This study aimed to explore an alternative technique of vibrating the base metal during aluminum welding to reduce hydrogen porosity. A vibration table was constructed to hold the base metal and administer the vibration. Aluminum coupons were vibrated at 0 rpm, 3,379 rpm, and 5,158 rpm during welding then radiographed. The radiographed images were used to count the porosity. The average porosity for each group were 45.8, 23, and 41.8, respectively. An analysis of variance (ANOVA) test found the p-value among the three groups to be  $>0.05$  (0.3507), so the data did not support a statistically significant difference. Although this vibratory method did not produce significant results, additional studies are necessary to explore it further. This study hopes to bring awareness to the dangers of porosity and inspire new approaches to improving the welding industry.

### **The Effect of Different Solutions on Hydrogel Crystal Release Levels**

*Suhani Samaroo, Clover Hill High School*

### **The Efficiency of Common Metals at Blocking Gamma Radiation in Comparison to Lead**

*Tyler Santini, Central Virginia Governor's School for Science & Technology*

### **The Effect of Types of Chemical Lightening on the Strength of Human Hair**

*Aidan Shenk and Sophie Snider, Washington-Lee High School*

The purpose of this experiment was to determine the effect of types chemical lightening on the strength of human hair. The hypothesis was, if different methods of chemical lightening were tested, then the most destructive method will be hair bleach because it has the strongest lightening properties. The experiment was conducted by taping a single strand of hair horizontally across two stacks of books. A cup was then attached to the hair using a binder ring. Pennies were placed one by one in the cup until the strand of hair broke. This was repeated 15 times per independent level. The hair lightened with hair bleach was able to hold the most weight, 131.4 grams, while the hair lightened with hydrogen peroxide held the least, 88.12 grams. The control group was in the middle holding 109.8 grams. An ANOVA test was conducted in order to determine the statistical significance of the data. The p value was 0.001 which was less than the critical value of 0.05. Due to this six subsequent T-tests were performed two of which were less than the critical value of 0.05. The data was therefore proven to be significant because the ANOVA and T-tests proved no significant difference between the means which shows that each

level had a different outcome. The data suggests that hair bleach does not cause as much damage as suspected. This study shows that there are many ways to lighten hair, although hair bleach is the most proficient option when lightening as well as maintaining strength. This experiment is relevant because one in every six women dye their hair. It is important to know which method of lightening is best for your hair.

### **The Effect of Different Oxidizers on the Chemiluminescence of Luminol**

*Trisha Taparia, Mills E. Godwin High School*

The purpose of this experiment was to find the effects of different oxidizers on the chemiluminescence of luminol. Hydrogen peroxide and sodium chlorate have been used as oxidizers for luminol in order to detect traces of blood at crime scenes, and they both may have similar impacts on the chemiluminescence of luminol. Solutions made of potassium ferricyanide, sodium hydroxide, and luminol were exposed to 1 mL of 3% hydrogen peroxide or 1 mL of lab grade sodium chlorate. There was no control in the experiment because luminol does not have a standard oxidizer that can be used for comparison. It was hypothesized that if 1 mL of hydrogen peroxide and sodium chlorate were put into a luminol solution, hydrogen peroxide would result in longer reaction times. The results showed that sodium chlorate, on average, had reaction times that were 00:08.51 seconds longer than hydrogen peroxide. A t-test was performed on the data and the data was found to be significant for hydrogen peroxide vs. sodium chlorate. Based on the results, the research hypothesis was not supported. The results are due to the fact that the length of the reaction times were based on the intensity of the blue color that luminol gives off. Sodium chlorate had a strong blue glow and longer reaction times, while hydrogen peroxide had a faint blue glow and shorter reaction times. These results can lead to further research about how different amounts of sodium chlorate affect the chemiluminescence of luminol.

### **Fabrication and Activity Screening of Surface Enhanced Raman Spectroscopy Substrates**

*Lars Wirstrom, Mathematics & Science Academy at Ocean Lakes High School*

The goal of this ongoing research is to find a method to create a silver nanoparticle surface that can be used as a Surface Enhanced Raman Spectroscopy (SERS) substrate, and to explore how changes in silver concentration and coating thickness affect substrates' SERS performances. A secondary goal is to examine the relationship between the physical properties of a SERS substrate and the levels of enhancement detected. Based on the results in the scientific literature, the hypothesis for the current research is that if a high concentration of silver ink with a low coating thickness is used to create a SERS active substrate, then it will produce the greatest enhancement. A previously known method was used to create a silver complex which decomposes into nanoparticles. Subsequently, an ideal solution composition was determined for creating a thin layer of ink across a microscope slide. Substrates were then prepared using a Mayer rod and varied silver ink concentrations. The Mayer rod wire size and occasionally the curing method were experimental variables that were investigated. To test for SERS activity, the enhancement of 4-mercaptophenylacetic acid was monitored using a Raman spectrometer. Substrates with a high silver ink concentration and coating thickness generated the greatest enhancement factor. The enhancement factor was determined for peaks associated with the phenyl ring vibrations ( $\sim 1100\text{cm}^{-1}$ ). The highest recorded

enhancement factor for the phenyl ring vibrations was 44,071. The results indicated a complex relation in creating SERS substrates from silver nanoparticles.

### **The Effect of Trimethylamine-N-oxide on Prevention of Protein Aggregation**

*Sabrina Ye, Mills E. Godwin High School*

Protein aggregation occurs when misfolded proteins accumulate inside or outside of cells in the body. Protein aggregates are often prerequisites to various diseases, such as Alzheimer's Disease or even breast cancer. The purpose of this experiment was to determine the effects of the chemical Trimethylamine-N-oxide (TMAO) and its interaction and prevention of protein aggregation. The three types of proteins used for research were amyloid- $\beta$ , tau, and HER-2. Aggregation of amyloid and tau can possibly lead to the development of Alzheimer's Disease, while HER-2 aggregates correlate to breast cancer. Protein samples were treated with a diluted TMAO solution (concentration 100 $\mu$ M), and aggregation was measured with a Thioflavin T fluorescence assay. Analysis of the results depict that amyloid-beta, tau, and HER-2 samples treated with TMAO had much lower average protein concentrations (160.4540, 162.1661, and 179.9018 RFU, respectively) compared to amyloid-beta and tau samples that did not have a chemical treatment (191.5957, 181.7770, and 194.7677 RFU). Furthermore, TMAO samples had lower average protein concentrations compared to samples treated with curcumin, a chemical that is already known to prohibit aggregation. Overall, the data was found to be statistically significant. The most likely reason as to why aggregation was prevented is due to the fact that TMAO acts as a molecular crowder and blocks protein from folding in the wrong places. The results of this research may lead to the development of potential methods of using TMAO to prevent a wide variety of diseases caused by protein aggregation.

## **Ecology and Earth Sciences A**

### **Combating Allergens Using Air Filters**

*Aidan Basloe, Swanson Middle School*

### **The Effect of Soil Type on its Capacity to Hold Water**

*Yalguun Baterdene, Thomas Jefferson Middle School*

### **Network Analysis of Virginia's Mineralogical Systems**

*Cadence Boucher, Home School*

The objective of this project was to use network analysis to identify patterns in Virginia's mineralogical system. Data was gathered from Mindat.org and put into an html code which produced a bipartite force-directed network of the minerals and counties of Virginia. The code was modified so that the size of the mineral nodes represented the number of localities the minerals are found in, and the size of the county nodes represented the number of minerals found in that county. Links were made to connect minerals to the counties they are found in. Colors of the nodes represent geophysical regions of the counties and different mineral attributes such as hardness, crystal structure, and mineral classification. This method of data visualization revealed several patterns such as the abundance of softer minerals near the blue ridge counties, the abundance of silicate

minerals near the Piedmont and Coastal Plain counties, and the related distribution of gold, silver, and copper.

### **The Effect of Micro-plastic Polymers on the *Ficus religiosa* Bodhi Tree's Shoot and Root systems**

*Desmen Boykin, Graham Park Middle School*

The purpose of this experiment is to observe the effects of different types of micro-plastic particles on the growth and health of the Ficus Religiosa (Bodhi) tree. It is hypothesized that, out of three plastics, Styrene Butadiene Copolymer (SBC/SBR), Polyethylene Terephthalate (PET), and Sodium Polyacrylate (SPS/SPA), if polyethylene terephthalate (PET) is used as one of the microplastic contaminants in tap water to grow and root the plant, then the plant would not decay as rapidly as it would in the tap water containing other microplastic polymers since PET is commonly used as a packaging material for liquids for human consumption. To perform this experiment, three different micro-plastic shavings from Styrene Butadiene Copolymer (SBC/SBR), Polyethylene Terephthalate (PET), and Sodium Polyacrylate (SPS/SPA) containing products, were placed in tap water containing three Bodhi Tree leaves and were placed in a hydroponic greenhouse. The results of the experiment showed that, among the microplastic polymers, the PET microplastics had the least negative effect on the leaf's plant growth when compared to the other micro-plastic polymers. More noticeably was the effect of tap water only when no plastic was present since multiple roots formed, and a vibrant deep green color was observed. It is clear from the experiment that microplastics adversely affect the Ficus Religiosa (Bodhi) tree. For this reason, more research should be performed to learn the negative effects of microplastic particle waste.

### **The Effect of the Type of Water on Soil Erosion**

*Natalie Cecil and Grace Varrieur, Swanson Middle School*

The majority of erosion control across the United States is put towards rivers, with their current and sediment build up they appear to be the biggest target for erosion. For this experiment the level of erosion for beaches, bays, and rivers were tested to find out what bodies of water have the greatest need for erosion control. The hypothesis was that if 250 mL of saltwater, freshwater, and brackish water were run through a man-made river, then saltwater would erode the most soil due to its increased density from the salt particles hitting up against the banks. To test this a man-made model with 100g of soil was built as the base. Then, 250 mL of the three levels of saltwater, freshwater, and brackish water were run through the model. Afterwards, the mass of the soil that had been washed away from the model was measured. The results clearly showed that saltwater eroded the most soil ranging from 4g to 13.4g. Brackish water ended up with the largest and most inconclusive data, ranging from 0.5g to 5.5g. Lastly, freshwater eroded between 0.6g and 2.9g. The data showed a weak positive correlation between the salinity of water and how much soil is eroded. The hypothesis that saltwater would erode the most soil was supported by the data. This demonstrates that the annual budget the United States allows for erosion control should be put towards beaches and estuaries.

### **The Effect of Different Types of Plants on Soil Erosion**

*Nikita Chandra, George H. Moody Middle School*

The purpose of this experiment was to find out which type of plant would prevent soil erosion the best. The hypothesis for this experiment is that if non-vascular plants are put in the soil, then the least amount of soil that is observed will be collected in the tray. To begin with, thirty aluminum loaf pans were filled with of the way with Miracle-Gro Garden Topsoil. In ten of the loaf pans, four ounces of grass seeds (independent variable) were spread evenly across the soil. In another ten pans, eight ounces of Preserved Spanish Moss (independent variable) were planted in the soil. The last ten loaf pans were left empty except the soil. This group was the control. Each of these loaf pans were weighed on a kitchen scale. Then, ten holes were punctured along the bottom edge of one side of every loaf pan. These holes served as drainage ways for excess water. One end (of each loaf pan) was attached to their own aluminum cake pans, using a hot glue gun, while the cut ends of the loaf pans were placed in a slanted position inside the cake pans. This step was to stimulate the slope of a hillside. The loaf pans were set up near a window with sunlight, which is one of the necessities of a plant life. Each loaf pan was then watered with four ounces of water from a watering can with a rain spout. This was repeated for the remaining nine trials. Lastly, all the loaf pans were weighed once more to see how much soil each pan lost. It was observed that the trays with the grass in them had the most amount of soil left in the tray (Appendix B). Also, the trays with only soil (control) had the least soil left in the tray (Appendix B). The mean of how much soil each plant lost in each category was calculated (Appendix A). The grass plants lost a mean of 1.67 ounces of soil. The moss plants lost a mean of 3.32 ounces of soil. The pans with no soil (control) lost a mean of 5.64 ounces of soil. Therefore, the grass (non-vascular (IV)) was the best plant to hold off soil erosion according to this experiment.

### **The Effect of Surface Texture of Wood on Water Absorption**

*Jennifer Chen, George H. Moody Middle School*

Wood decay is a growing concern in the outdoor furniture industry due to its effect on the longevity of the wood and the piece of furniture. The decomposition process begins when water is absorbed through the porous surface of any untreated wood and is retained in the fibrous structure, eventually softening the wood and compromising its structural integrity. Due to the role of water in the process, wood is most susceptible to decay in areas where precipitation levels are high, making it concern in many coastal states, including Virginia. The purpose of this experiment was to determine how wood would absorb water when the surface is sanded, a common step in the wood treatment process. In this study, red cedarwood samples were sanded with different grits of sandpaper. They were then left submerged water and the change in weight was recorded. The results indicated that there was no significant change in water absorption between the groups. A t-test performed on the data indicated no significant difference between the means of the groups. The data did not support the research hypothesis that there would be an indirect correlation between sandpaper grit and water absorption. According to the data collected from this research, there does not appear to be any correlation between the surface texture of wood and the amount of water absorbed. Careful evaluation of the methodology of the experimentation reveal that corrections to the variations in sanding and drying times can be implemented to account for errors that could have affected the results.

### **The Effect of Active Energy Conservation on Reducing Carbon Footprints**

*Elaine Chu, Thomas Jefferson Middle School*

The purpose of this study was to determine if practicing active energy conservation of water, electricity, and natural gas in a home reduces a household's carbon footprint. The independent variable was the level of energy conservation practiced in the household: active energy conservation (truly trying to conserve as much as possible) and usual energy conservation (a level of conservation that occurs when not intentionally focusing on conservation). The dependent variable was the change in the household's carbon footprint. The constants included the footprint calculator, the calculator's methodology, and consistency of each level of conservation. The hypothesis was: If the active energy conservation of water, electricity, and natural gas is practiced in a home, then the household's carbon footprint will be reduced. The household's water, electricity, and natural gas usages when practicing each level of conservation were calculated from meter readings, bills, water measurements, and estimations. From these usages, the household's carbon footprints for each level of conservation were calculated using a footprint calculator. Finally, the household's carbon footprints were compared and the change in the footprints were calculated. The results showed that practicing active energy conservation reduces the household's carbon footprint because less water, electricity, and natural gas is consumed. These results support the hypothesis. In conclusion, the study suggests that making more simple and easy efforts to actively conserve energy every day is an effective way for individuals and households to reduce their carbon footprints. These efforts like turning down the heat in a home may only make a small change for one household's carbon footprint, but it will make a tremendous difference if everyone contributes.

### **The Effect of "Green" Versus "Conventional" Detergents on Worms**

*Richa Dhakal, Thomas Jefferson Middle School*

The purpose of this study was to find out if eco-friendly or "green" dish detergents are truly less harmful to the environment. The independent variable was different brands of "green" or "conventional" dish detergents. The experimental group included: Dawn Dish Detergent, Palmolive Eco-friendly Dish Detergent, Seventh Generation Dish Detergent, Palmolive Dish Detergent, Gain Dish Detergent, and AJAX Dish Detergent. The control was no detergent. The dependent variable was the amount of worms alive after five days. The constants included: the same species, age, starting number of the worms, amount of light given, bowls, spoons, number of holes in the aluminum foil, aluminum foil, type of soil, amount of dish detergent, and amount of soil. The hypothesis was: If four red wiggler worms are put into a mixture composed of 20 ml of Seventh Generation Dish Soap and 100g of potting soil, then they will have the most worms alive. Five large (177 ml) cups were prepared by mixing 236.59 g of potting soil and 20 ml of the first type of dish soap. Four worms were dropped into the cup then covered with tin foil. Then, 10-12 holes were evenly dispersed throughout the tin foil. The different IV variables were then tested. The amount of worms alive in each cup was recorded. The results suggested that Palmolive Eco-Friendly Dish Detergent kept the most worms alive after five days. These results rejected the hypothesis. In conclusion, the study suggests that Palmolive Eco-Friendly Dish Detergents is the least harmful to worms.

### **The Effect of Various Forsterite Sand Quantities on the Toxicity of Tap Water and Carbon Dioxide Solution**

*Anya Dutta, Thomas Jefferson Middle School*

The purpose of this study was to test the effects of various forsterite sand quantities on the toxicity of a tap water and carbon dioxide solution. The independent variable was the quantities of olivine sand. The experimental group included the following quantities: 7.5 g, 15 g, 22.5 g, 30 g. The dependent variables were; the carbon dioxide and nickel levels in the water. There was no control group. The constants were: the mesh (grain size) of the sand (120), the type of water (tap), water amount (300 mL), the brand of CO<sub>2</sub> tablets (ISTA), and the type of cup (standard plastic solo cup). The hypothesis was: If 15 grams of olivine sand are poured into the solution, then the toxicity, determined by carbon decrease and nickel increase, will be the lowest. The forsterite sand was separated into 5 counts of 7.5, 15, 22.5, and 30 grams, and each count was poured into a tap water and carbon dioxide solution where TDS and nickel ion levels were measured. Every day for a week, the mixture in every cup was stirred with a hand mixer for 30 seconds. After a week the total dissolved solids (TDS) were measured again, factoring out the input from the dissolved forsterite, the nickel ion levels were measured, and the difference of carbon dioxide calculated by using measurements from the TDS meter, and the change in nickel ion levels were recorded into a data table. The results did not support the hypothesis. In conclusion, the study suggests that there is a limit as to how much olivine, and likely, other types of alkali (e.g., calcium carbonate), should be used at a time because they can lead to almost, or just as destructive side effects, such as the killing of certain species.

**The Effect of Type of Water on Paper Degradation**

*Sarah Eichorn, Thomas Jefferson Middle*

The purpose of this study was to find out in what type of water paper degrades fastest. The independent variable was the type of water the paper is placed in. The experimental group included distilled water, fresh water, brackish water, and sea water. The control group was fresh water. The dependent variables were the change in pH in the water and the mass change in the paper, which helped identify the amount of paper degradation. The constants were: the amount of water, size of paper, and amount of time left to sit. The hypothesis was: If paper is placed in saltwater, it will degrade the most. The experiment was conducted by filling four tubs with different types of water, and after the paper had been weighed and the water pH tested, one piece of paper was placed in each tub and left to sit for a week. After a week, the papers were taken out and weighed again, and the pH was measured as well. The experiment was repeated a total of 3 times. The results showed that the mean of the saltwater paper was the highest, meaning the degradation was the greatest in the saltwater. The results accepted the hypothesis. In conclusion, the study suggests that paper in saltwater degrades the most because of higher salinity levels.

**The Effect of Angle on Thermal Radiation on Temperature Increase of Water**

*Willa Eisnehauer, George H. Moody Middle School*

Heat transfer takes three forms: convection, conduction, and radiation. Thermal radiation does not need a physical medium to be transmitted through; it would work in a vacuum. Water covers our planet and receives thermal radiation from the sun. The purpose of this experiment is to determine the effect of the angle of thermal radiation on the temperature increase of water. This research could be helpful for the solar heating of water, as well as storing heat in water. Based on the idea that stated that the warmest time of day is when

the sun, or thermal radiation, is at a 90°, it is believed that if the thermal radiation is positioned at three different angles (0°, 45°, 90°), then the group receiving thermal radiation at a 90° angle will have the greatest temperature increase. Four different basins were set up and four liters of room temperature water were poured into them. Each basin received thermal radiation at a different angle, these angles being no radiation as the control group, from a 0° angle, from a 45° angle, and from 90° angle. The heat lamp was placed at the correct angle and 20 centimeters away from the center of the surface of the water. The temperature of the water was taken and recorded, then the heat lamp was turned on and a stopwatch started. The temperature was recorded every fifteen minutes. This process was repeated five times for each level of the independent variable. The temperatures were averaged across the trials, and the difference between the average start time and the average end time for each level of the independent variable was found. This measurement was compared to the other levels of independent variable. The data supported the research hypothesis because the group receiving thermal radiation from a 90° had the greatest amount of temperature increase.

### **Root Length of Soil Erosion Fighting Plants**

*Cassie Elsberg and Rebecca Estevao, Swanson Middle School*

Sedimentary pollution is a huge part of water pollution. Soil erosion occurs when running water picks up dirt and sediment, and then runs into the nearest body of water. Our experiment tested the root growth and lengths of different soil erosion fighting plants. The ultimate goal was to find the best plant to help prevent erosion and sedimentary pollution in flood-prone areas. We experimented with three known types of erosion-fighting plants, including tall fescue, blue fescue, and periwinkle. Before experimentation, we predicted that tall fescue would have the longest roots at the end of the one month growing period. After a month the roots were measured by pulling the plants out of the soil, shaking off the dirt, and stretching out the roots. After experimentation, we concluded that tall fescue did grow longer roots than both periwinkle, and blue fescue over the monthlong period. Individuals who live in flood prone areas, areas with a wet and a dry season, and many others can use the results of this experiment to protect their topsoil and prevent further pollution to their watershed.

### **The Relationship between City Green View Index and mean Air Quality Index Value of Particulate Matter**

*Kara Felker, Thomas Jefferson Middle School*

The purpose of this study was to find the relationship of the green view index (GVI) of a city on the air quality index (AQI) value of particulate matter with a diameter of <2.5 microns (PM2.5) during the year 2017. The independent variable was the GVI of a city. The experimental group included: Tampa, with a GVI of 36.1%; Sacramento: 23.6%; Seattle: 20%; Miami: 19.4%; Los Angeles: 15.2%; and New York City: 13.5%. There was no control group. The dependent variable was the mean AQI value of PM2.5 over the course of the year 2017. The constants were the source of data for the GVI, the source of data for the AQI value, and the dates of the AQI values for each city. The hypothesis was: If cities have a higher GVI, then those cities will have lower PM2.5 AQI values. Two google sheets files were created and set up with city names as headers. The data was then entered into one google sheet file, and 11 statistics were found. The statistics were



entered into the second google sheets file and two graphs were made. The results suggest that there might be a positive relationship between the GVI of the cities and mean PM2.5 AQI. This supports the hypothesis. In conclusion, this study suggests that the relationship between the GVI of a city and its mean PM2.5 AQI value is complex but planting trees cannot hurt.

### **The Effect of Type of Worms on the Degradation of Polyethylene**

*Suyana Fernandez, Thomas Jefferson Middle School*

### **The Effects of Different pH levels of Springwater on Population of *Daphnia magna***

*Ava Fischer, Thomas Jefferson Middle School*

The intent of the study was to determine the effects of different pH increments on aquatic microorganisms, specifically *Daphnia magna*, in a controlled micro-environment. The independent variable was the different pH levels of the spring water. The experimental group included water with a pH of 4, 5, and 9. The control group was the group with a pH of 7, since water with a pH level of 7 was the optimum pH for microorganisms. The dependent variable was the number of *Daphnia magna* out of five that survived in the different groups of spring water with separate pH increments. The constants included: the type of beaker, the temperature of the water, the number of *Daphnia Magna*, and the date tested. The hypothesis is: If spring water that has a pH level artificially changed and has five *Daphnia Magna* placed in the water, then the beaker with a pH of seven will have the most *Daphnia Magna* still alive. Four beakers were filled with water and had materials added to artificially change the pH. *Daphnia Magna* was placed in the water, and after 24 hours, was tested for population out of five. The results showed that all the beakers, with the exception of the control group, had similar survival rates, with no survival rate greater than 5%. Thus, the results accepted the hypothesis. In conclusion, though not all pollution changes the pH of water too drastically, it still has a lasting effect on the surrounding environment.

### **The Effect of Natural Herders on the Efficiency of Petroleum Removal from Water**

*Ananya Gomatam, George H. Moody Middle School*

Oil spills happen all over the world and cause negative effects on marine and coastal environments, as well as the organisms living there. Methods to clean up oil spills are available, however, not all of them are environmentally friendly. The purpose of this experiment to find out which natural herder would be most efficient in removing petroleum from water. To perform the experiment, oil spills were replicated, and the herder was sprayed on the petroleum. The amount of petroleum removed was calculated and the averages were graphed. The results indicated that the group that removed the largest amount of petroleum had a herder with coconut oil and chlorophyll (35.3mL removed) and the group with a herder of cocoa butter and chlorophyll (26.2 mL removed). The data did not support the research hypothesis that if olive oil and chlorophyll were used, then the most petroleum would have been removed. Based on the data collected, a herder with coconut oil and chlorophyll would be the most efficient in removing petroleum. Compared to other research, the ideas in this experiment are similar, because plants and plant byproducts are a mutual substance to use when developing biodegradable oil herders.

## **The Effect of Different Lights on the Amount of Bacterial Colonies in Water**

*Nitya Goyal, George H. Moody Middle School*

Provision to safe drinking water is one of the most important things for a country to have. Many of the people in the world who lack an improved water source instead drink from rivers, lakes, or other unimproved sources of water. Common waterborne diseases such as Giardia and Norovirus are the cause of over 3.4 million deaths annually. Many people have created water filtration systems that are both cheap and effective. However, these can be hard to access in the less developed, more remote and rural areas. Instead, people in need of clean drinking water can use light. The purpose of this experiment was to test the effect of different types of light on the number of pathogens in water. The research hypothesis of this experiment was if the water samples are placed under UV light, then the number of bacterial colonies will decrease. The water samples from the James River were placed under bulbs of different kinds of light to examine which samples eliminated the most pathogens. After the water samples were treated, they were transferred on to soy agar plates and observed after three days. When the results were analyzed using mean, the water samples under ultraviolet light showed the greatest decrease in bacteria from the control group (9.2% decrease). The results of this experiment support the hypothesis. In conclusion, the ultraviolet light was the most effective in removing pathogens from the water samples.

## **Ecology and Earth Sciences B**

### **The Effect of Different Environments on the Mass (g) Reduction of Decomposing Bioplastic**

*Gayatri Guda, George H. Moody Middle School*

In today's world, plastic pollution is a major problem faced by humans as well as the environment. When plastic is disposed of, it ends up in landfills or finds its way into natural habitats. Biodegradable plastic is able to decompose with naturally occurring microorganisms, like bacteria, fungi, and algae. The purpose of the experiment was to determine how biodegradable plastic, or bioplastic, would react to different environments and which one would cause the most mass reduction in the sample. Before experimentation, bioplastic was made using water, tapioca starch, tap water, anhydrous glycerin, and distilled white vinegar, enabling it to decompose. These samples were placed in compost, pond mud, potting soil, and rocks and left for a month. The hypothesis of "If the bioplastic was put in a container of pond mud for an extended period of time, then it would lose the most mass and have a higher rate of decomposition than in compost, potting soil, or rocks." is supported by the evidence of decomposing matter in ponds and the microbes that initiate the reaction. The results showed that the mean mass reduction of the plastic in the compost (1.58 g) was greater than the mean mass reduction of the plastic in the other levels of IV and that the plastic lost 31.6% of its mass. This was the most effective of the levels of IV, although the trials in pond mud lost 29% of their mass in the same month. The null hypothesis was rejected in all tests and the results were significant when the control was compared to the pond mud ( $t=1.83$  at  $df=9$ ;  $p<0.05$ ), potting soil ( $t=5.73$  at  $df=9$ ;  $p<0.05$ ), and rocks ( $t=28.34$  at  $df=9$ ;  $p<0.05$ ); therefore, the hypothesis was not supported. This may have been because further research shows that compost provides the perfect moist, nutrient-rich environment to harbor sufficient bacteria

as well. The bacteria released water and carbon dioxide as a waste produce as they break down their food, or the bioplastic.

### **The Effects of Erosion on Different Types of Soil**

*Dillon Humphrey, Sabot at Stony Point*

Soil erosion is a very big problem and it is making life for farmers, and regular people more difficult. Soil erosion is caused because of rainfall and high-speed winds, this study was testing water and soil erosion. The purpose of this experiment was to find the most resistant soil to soil erosion out of three different types of soils and the soil that is most susceptible to soil erosion. Erosion of the solid was tested by pouring water over the soil and then measuring the amount of displaced soil. The test showed that sand was the most susceptible soil to soil erosion, after the test was complete the results showed that there was an average of 1.8 kg of sandy soil lost compared to the amount of clay and topsoil lost. The test results also showed that topsoil was the most resistant soil to erosion, the results were not consistent with prior research because all the research that was done showed that clay should be the most resistant soil to erosion since the size of clay particles are the smallest. The results showed that clay usually lost a total amount of 0.7 kg of soil. Topsoils results showed that the soil lost a total amount of 0.4 kg of soil. The results of this experiment did not support the hypothesis.

### **The Effect of Different Types of Cost-effective Barriers on Fertilizer Runoff**

*Sania Jain, George H. Moody Middle School*

Increase in synthetic fertilizer usage has benefited crop yields but has resulted in a lot of unabsorbed fertilizer in the form of nitrates ending up in the water stream. Nature has historically used bacteria to denitrify the excess nitrates that end up in the water stream due to pollutants like manure etc. However, excess synthetic fertilizer has increased to a point where nature is only able to denitrify a small portion of the nitrates in the water stream. This results in a lot of nitrates being carried into the sea, creating miles and miles of algae-bloom and dead zones devoid of marine life. This paper looked at potential barriers that could remove nitrates from runoff water at the source itself as solution to this problem. The tested barriers were cotton, play sand, baking soda, volcanic rock, and the control group, no barrier. The hypothesis was that volcanic rock would be the most effective barrier in removing nitrates. The results pointed to baking soda being the most effective at removing nitrates and volcanic rock being the least successful of all the barriers tested.

### **The Effect of Bleaching Triggers on Coral Reefs**

*Jayadeepika Jayasekar, Thomas Jefferson Middle School*

### **The Effect of Fertilizer Brands on Nitrogen in Water**

*Cheyenne Klapper, Thomas Jefferson Middle School*

The purpose of this study was to see which brand of fertilizer affects water the most. The independent variable was the different brands of fertilizer. The experimental group included these conditions: Virgo Lawn Fertilizer, Scotts Turf Builder, and Dr. Earth Root Zone. The control group was no fertilizer. The dependent variable was the amount of nitrogen in water. The constants included the size of plastic bin, amount of fertilizer,

nitrogen soil tester, amount of soil, size Lawn Seed Blanket, area where tested, number of tests, wait time when drained, and time and temperature when tested. The hypothesis was: If Virgo Lawn Fertilizer is tested for how much nitrogen is in it in water, then Virgo Lawn Fertilizer will contain the most nitrogen in water. Four bins were placed on a patio all containing soil and an equally cut Lawn Seed blanket. All the bins had either a certain brand of fertilizer and one bin contained no fertilizer. Water was poured into each bin and was tested for how much nitrogen was in them. The results showed that Scotts Turf Builder contained the most nitrogen in water. The results rejected the hypothesis. In conclusion, the study suggests that Scotts Turf Builder contains the most nitrogen and buyers who use fertilizer should limit themselves from Scotts Turf Builder, because of its potential impact on the environment.

### **How Much Water Do I Really Use?**

*Marley Kurey, Swanson Middle School*

The objective of my project was to inform people like me, who are concerned about the environment and how much water they use, about the many different types of shower heads you can buy and what to look for and research when you are buying them. I tested the flow rates of three different types of shower heads: a Niagara Tri-Max, Delta Single-Spray, and Moen shower head, to see which one was the most water-saving. My results were that a Niagara Tri-Max showerhead used the least amount of water out of the three, and had the lowest GPM (gallons per minute) flow rate. Moen showerhead ended up using the most water. There ended up being a very big difference between the Niagara shower head and the other two in how much water was used by each. The project could be very helpful to people who are concerned about how they can conserve water, but also those that do not know ways to be more environmentally aware.

### **The Effect of Filtration Method on Protozoa Remaining in Water**

*Freya Matheson, Thomas Jefferson Middle School*

The purpose of this study was to determine which method of water filtration removed the most microscopic parasites from the water. The independent variable was the method of water filtration used. The experimental group included: a backpacking filter, a home water filter, a UV light, bleach (in the place of chlorine), and boiling the water. The control group was unfiltered water. The dependent variable was the number of protozoa and parasites at remain post filtration. The constants were the kind of protozoa used, kind of water used, starting temperature of water, and where the water is stored/filtered. The hypothesis was: If the water is boiled at 70°Celsius, the most protozoa will be killed. The experiment was conducted by filtering water five different ways and seeing which one was most effective. Results suggested that all methods of filtration except home filters are equally effective in filtering basic protozoa out of water. In conclusion, there is no great difference between methods, and all have essentially the same effect on basic parasites in water.

### **The Effect of Different Curbside Inlets on the Proportion of Plastic in Storm Drains**

*Anmol Mital, George H. Moody Middle School*

Water plastic pollution is a crucial problem in our world, becoming not only an eyesore but also an immediate threat to our environment: ocean litter fills up entire stomachs of

marine animals and is deadly to the biodiversity of our oceans. Storm discharge, an important source of ocean plastic, enters storm drain inlets (e.g. curbside inlets) and flows into creeks and rivers, eventually reaching the ocean. By improving the design of storm drain inlets, we can reduce the plastic that enters the ocean. The purpose of this experiment was to determine the effect of variations of curbside inlets (CIs) on the proportion of plastic (beads and bottle caps) allowed into the inlet. Four CI models (common CI, CI with small mesh, CI with large mesh, and CI with star-shaped mesh) were constructed. A measured number of beads and bottle caps were placed on the model and 90 mL of water was poured. The percentage of plastics allowed, and water captured by various CIs was calculated. All of the experimental levels (CI with small mesh, CI with large mesh, and CI with star-shaped mesh) allowed no bottle caps through while the control allowed 70% of bottle caps. The CI with large, small, and star-shaped meshes allowed 36.25%, 4% and 3.5% of beads in respectively compared to the control inlet which let 73.5% of beads in. The results confirmed the hypothesis that if different CIs are used, then less percentage of plastics would pass through the different inlets (CI with small mesh, CI with large mesh, and CI with star-shaped mesh) compared to the common CI. Thus, the mesh type at the inlet affected the proportion of plastics that escaped. Additional research should be conducted using different material of meshes to determine sustainability (cost-effectiveness and durability) of the material.

### **The Effect of Different Liming Materials on the pH of Soil**

*Akshay Pappu, Pocahontas Middle School*

### **The Effect of Location on Water Quality**

*Mia Pisacane, Thomas Jefferson Middle School*

The purpose of this study was to find the effect of location on water quality. The independent variable was where the water was collected. The experimental group was water from: (1) Lewis Springs, (2) Shenandoah Park (Shenandoah), (3) Pebble Creek (Shenandoah), (4) River Bend Ranch, (5) Morgan Ford Rd, (6) Manassas Run, (7) John Brown's fort, (8) Harper's Ferry, (9) C & O Canal Lock 33, (10) Thompson's Boat Dock, (11) River Bend Park, (12) Dulles Airport, (13) Washington Sailing Marina, and (14) Four Mile Run. The control group was water from Lewis Spring. The dependent variable was the water quality testing of the pH, dissolved oxygen level, temperature, and turbidity. The constants were: the amount of water taken, the kits used to test the water, and the procedures. The hypothesis was: The river water collected from Lewis Spring will have a pH between 6 and 8.5, dissolved oxygen levels closest to 4-6mg/l, temperature lower than 31o Celsius, and turbidity close to 0. At the location of the water sample, tests for turbidity, pH, dissolved oxygen, and temperature were done. The results showed that the pH stayed in the same general area, between 6 and 7. The turbidity was better after the Potomac and Shenandoah merged together compared to the Shenandoah River. There was more dissolved oxygen in the Shenandoah and after the Potomac Shenandoah merge compared to the Potomac. The temperature was lower in the Potomac than in the Shenandoah or after the Potomac Shenandoah merge. These results reject the hypothesis. Only two of the tests supported the hypothesis. In conclusion, the study suggests that Virginia's rivers meet the requirements for river quality. Based on the

findings of this study, other studies that should be done are studies on bacteria levels of *E. coli* in the Shenandoah River.

### **The Effect of Different Schools on Water Fountain pH**

*Nabela Rahman, Kenmore Middle School*

During the day, many students get thirsty and drink from the water fountains provided by their school, but how do they know the water they are drinking is acidic, basic, or neutral? The purpose of this project was to verify whether the water that middle school students in Arlington Public Schools drink from is neutral or not by checking the pH of water from each school's water fountains. pH is a scale used to measure how acidic or basic a solution is. The scale is generally from 0-14. 0-6 meaning acidic, 8-14 meaning alkaline, or basic, and 7 resulting as neutral. The hypothesis for this experiment was if the water samples were collected from Swanson Middle School, then the pH would be the farthest from the pH level 7. The independent variables were the schools, specifically Kenmore Middle School, Swanson Middle School, Williamsburg Middle School, and Thomas Jefferson Middle School. The dependent variable was the pH each school received. pH papers were used for this experiment and the scale was measured from 0-13. The experiment was performed by collecting water samples from each school and taking them home. Next, a pH strip was placed into one of the water samples for no more than one second. Once the pH strip was out of the water, three seconds were waited. Then, the color of the strip was compared with the color on the key that was given with the pH kit. Finally, the data was recorded. This was repeated for all sixteen trials. Each school received the pH level 6 (acidic) for all sixteen trials. The hypothesis was that if the water samples came from Swanson Middle School, then the pH would be the farthest from the pH level 7, which concludes that the data did not support the hypothesis, therefore, the hypothesis was rejected.

### **The Effect of Carbon dioxide on Ice**

*Kritika Rai, Thomas Jefferson Middle School*

The purpose of this study was to test the effects of Carbon dioxide on ice. The independent variable was the amount of Carbon dioxide. The experimental group was ice exposed to additional carbon dioxide. The control group was ice not exposed to additional Carbon dioxide. The dependent variable was the mass of ice after being exposed to or not exposed to additional Carbon dioxide after a certain period of time. The constants in this study were the temperature, the starting amount of ice, and the starting amount of Carbon dioxide. The hypothesis was: If additional Carbon dioxide is introduced into the atmosphere around ice, then the ice will have lower mass than ice not exposed to additional carbon dioxide. Ten blocks of ice were each observed; five were exposed to normal levels of carbon dioxide, the other five were exposed to additional carbon dioxide. They were kept in the freezer for three hours, at 3.33°C. The results show that the ice blocks in the experimental group (exposed to additional Carbon dioxide) had a lower mass, with a mean of 0.65 kg. The ice blocks in the control (no additional Carbon dioxide) had a higher mass than the experimental group, with a mean of 0.68 kg. These results support the hypothesis. In conclusion, the study suggests that Carbon dioxide does have an effect on ice mass.

## **The Effect of Dish Soap on the Survival Rate of Worms**

*Estee Ruiz, Thomas Jefferson Middle School*

The purpose of this study was to find the effect of eco-friendly dish soaps on the survival rate of worms. The independent variable was the type of dish soap. The experimental groups were Dawn and Palmolive, brands considered conventional soaps, and Sun and Earth and Seventh Generation, brands considered eco-friendly. The control group was the soil without any dish soap. The dependent variable was the survival rate of the worms. The constants were the amount of compost given, the amount of sunlight given to each tub of soil, the amount of water given to each tub of soil, the number of worms to start with in each tub and the type of worm in each tub. The hypothesis was this: If worms are exposed to the same amount of dish soap for a week, then the worms exposed to the eco-friendly soaps will have a greater survival rate. Three trials were conducted for each condition. 15 containers were filled with 500 g of potting soil and the solution of water and 11% dish soap was gently poured onto the soil. Fifteen worms were then placed on the soil with the solution. In addition, 20 g of assorted vegetables were placed on the top as food for the worms. The containers were checked two times during the five-day period, and the amount of worms alive was recorded. Once all the data was gathered, a graph depicting the information was made. The results showed that the worms that received just water (the control) had a greater survival rate than any other level. However, the worms in the Sun and Earth container had the second highest survival rate. These results support the hypothesis. In conclusion, the study suggests that eco-friendly dish soaps have a positive effect on worms compared to the regular, conventional dish soaps.

## **The Effect of Different Pollutants on the Health of Brine Shrimp**

*Skylar Schuetze, George H. Moody Middle School*

## **The Effect of Water Depth on the Frequency of Waves**

*Mahi Shah, George H. Moody Middle School*

Seismic waves (tsunamis) are generated by earthquakes at sea. The largest seismic sea-wave was created by the impact of the K-T meteor 65 million years ago. Most tsunamis are caused by seismic waves. The most dangerous part of a tsunami is its persistence of its waves. As water levels increase, a tsunami could do more damage than before. The research can be useful to help predict the danger of the wave that is headed for the coast. The hypothesis was; If the container was filled to the four centimeters mark then group(B) will create the most waves. A container (eighteen centimeters by fifteen centimeters) was vertically measured and marked by two, four, six, eight or ten centimeters. For the first group, Group A, the container was filled to the two centimeters mark. The same was done for the rest of the groups and trials. Group B was filled to four centimeters, Group C was filled to six centimeters, Group D was filled to eight centimeters and Group E was filled to ten centimeters. Afterwards, a five-pound weight was dropped at  $\frac{1}{3}$  of the container and the number of waves then counted by the experimenter. The data did not support the hypothesis. Group B did not have the greatest average number of waves created. For an experiment that would best replicate the process of a tsunami in the real-world, all the factors of the experiment should be made at a larger scale.

## **The Effect of Location on Nitrogen and Phosphorus Amounts in Water**

*Maya Sherlick, Thomas Jefferson Middle School*

### **The Effect of Different Dish Soap on the Efficiency of Oil Removal from Goose Feathers**

*Mabia Sikder, George H. Moody Middle School*

When cleaning, the first thought that comes to mind is soap. One of the leading dish soap brands today is none other than Dawn. It has been commonly associated with oil spill rescue cleanups. The most heavily impacted of all the wildlife in oil spills are the birds. When crude oil from these spills gets on a bird, the feathers are clotted up and lose their insulation. Rescued birds from these oil spills are washed using mild soaps. Without the soaps, the birds' feathers would not get cleaned properly and thoroughly. The purpose of this project was to determine whether or not Dawn dish soap really was the most effective when it came to oil cleanups. There are many eco-friendlier, gentle, dish soaps available too. The hypothesis was that if the feathers are washed with Dawn dish soap, then the oil will be removed more efficiently. This is believed because of how Dawn's chemical composition is different from that of other leading brands. Eighty feathers were dipped in modeled crude oil and used for this investigation. Broken into groups of twenty, the feathers were massed and washed with their corresponding dish soaps. They were then massed again and the difference between the initial and post masses was found. The feathers washed with Dawn (0.42 grams) ended up with a mean double to that of the feathers washed with Simple Truth (0.21 grams). The research hypothesis was supported since the Dawn group ended up with the largest mass of removed oil.

### **The Effect of Different Types of Heavy Metals on the Purification of Water**

*Sruthi Vegunta, George H. Moody Middle School*

The purpose of the project was to find if certain heavy metals affected the Total Dissolved Solids (TDS) of the water in a positive way (purified). The purpose included observing the change in TDS when water came in contact with iron, copper, lead, and zinc. It was hypothesized that if heavy metals are used for water purification, then copper would most effectively purify the water. Pollution caused by bacteria and toxins have caused a drastic change in water quality, threatening the lives of several water organisms. Water, a vital factor to sustain life, comes in a small amount, but much of the small percentage is not drinkable due to pollution. Four different individual strips of metal (127 x 25 mm), copper, iron, lead, and zinc, were each exposed to 200 mL of water for 24 hours. The Total Dissolved Solids (TDS) levels were counted before and after the experiment in each cup. The water with no metal was chosen as the control since the river water could then be compared to the data with the metals in the water to determine whether the heavy metals had any effect. Data collection revealed that the TDS levels for all of the different independent variables and the control increased, but at varying levels. The TDS of the control water gradually increased normally, but iron and lead both increased the TDS with the same average. Copper and zinc, on the other hand, raised the TDS higher; except copper barely did more than iron and lead, while zinc raised the TDS levels the highest by a large margin. It is believed that the results were due to the fact that copper has purifying properties and kills algae, so it slowed down the rise in TDS. Lead, iron, and zinc are toxic and react with the liquid to create substances which are poisonous to the



harmful bacteria in water. The effects of natural elements on water quality could be researched as a potential further study.

### **The Effect of Beet Juice Concentration on the Melting of Ice**

*Sarah Wager, George H. Moody Middle School*

## **Engineering A**

### **Comparing the Durability of Shin Guard Materials to Metal Alternatives Through Shock Absorbance**

*William Adu-Jamfi, Central Virginia Governor's School for Science & Technology*

The purpose of this study was to identify the widespread presence of leg injuries in soccer, the need to improve the durability of shin guards, and how metal alternatives such as brass, copper, and aluminum could be a solution to this problem. The hypothesis was that, if metal alternatives and shin guard materials underwent impact testing then all three metal alternatives would have a higher shock absorbance than shin guard materials and consequently would have a higher amount of durability. After metal alternatives and shin guard materials underwent impact testing, the X, Y, and Z accelerations were recorded and then converted into one total acceleration. The total acceleration was then multiplied by each material's individual mass in order to find their impact force (Newtons). A one-way ANOVA test was used to analyze the data and a p-value of  $1.13E-36$  was produced, which was compared to my alpha value of .05. A Post hoc Tukey test was then used, with a D min of 7.64, and it was found that there was a statistically significant difference between every group. Moreover, shin guard materials had the lowest average force at 2.52 N, and this therefore suggested that they are more durable than metal alternatives, which did not support the original research hypothesis. In summation, the results suggest that shin guard materials are more durable than metal alternatives, and that metal alternatives are not the solution to improving the durability of shin guards.

### **Triaxial Attitude Control of a Picosatellite Using Stimulated Emissions**

*Neema Ahmadian and Emerson Dove, Blacksburg High School*

Nanosatellites are increasingly popular in space missions for research, government, and commercial applications. These satellites have a body mass of 1-10 kg, while picosatellites have a mass of only 100-1,000 g. A major challenge for smaller spacecraft is the limitation of a small internal body volume. Thus, the larger volume requirements of traditional methods cannot be used to stabilize and achieve 3-axis control of satellite orientation. This project explores the viability of a novel approach to attitude control in small satellites. Our approach uses boom-deployed lasers to emit radiation, or photonic pressure to provide precise impulsion control to stabilize a picosatellite upon deployment into space in order to achieve high-precision orientation towards the sun, moon, earth surface, etc. The goals of the study are: 1) Develop an analytical model to determine the effect of radiation pressure on a tetragonal craft in a frictionless environment; 2) Optimize findings from the model results to determine the most effective design parameters for a spacecraft body; 3) Evaluate competing influences on the design to assess viability. The analytical model constructed focused on a theoretical design to describe the amount of time required to decelerate and halt (or modify) the motion of a rotating body released

into space. First, we derived the equations to quantify the dependence of torque (on the craft) on the force of laser and distance from the center of the craft. We then determined the optimal craft parameters by minimizing the time to stabilization and compared the design to the performance in different atmospheric densities. The resulting model design showed that a laser-based control system is a promising approach and could lead to smaller and more cost-effective picosatellites.

### **Designing a 16-bit microcontroller in VHDL**

*Evan Allen, Mathematics & Science Academy at Ocean Lakes High School*

In today's connected world, small computers called microcontrollers are becoming significantly more relevant. For decades, researchers have collaborated to design faster and more power-efficient microcontrollers. Because of the complexities inherent in microcontroller architecture, it would be convenient to have a simple baseline design that could be easily modified to study these issues. This project sought to design a 16-bit microcontroller to fulfill this role, one capable of executing user-specified programs made from a small but extensible instruction set that included arithmetic, control flow, and memory manipulation operations. An assembler was first built to allow users to write programs using the custom instruction set. The microcontroller's design was programmed in the VHDL hardware description language using the Aldec Active-HDL software. The microcontroller contained program storage, memory, peripherals, and a processor. Each individual component was tested by electronically simulating its operation under various stimulus signals, and then the entire microcontroller was tested by placing an assembled program into its memory and comparing its simulated output to a predetermined one. Example test programs included a program that printed Fibonacci numbers to memory and another that provided a steady pulse to the output peripherals. Each program was correctly executed, indicating that the project succeeded in its goal of creating a functional microcontroller. In the future, this microcontroller could be used to provide a baseline against which new architectures can be compared.

### **Velocity Limiting Exoskeleton for Children with Cerebral Palsy**

*Alexandra Barrett, Southwest Virginia Governor's School*

Assistive robotics, or exoskeletons, have become more prevalent in today's society, being used as rehabilitation and injury prevention devices. This project examined the effectiveness of a velocity limiting exoskeleton for the purpose of helping children with spastic cerebral palsy gain independence while eating. The goal was to determine if an exoskeleton designed for the arm would be able to control the velocity of a child's arm during a spastic movement, or jerk, using dampers. Using aluminum bars, gas springs, an elastic strap, and a soft interface made of foam and stretchable fabric, the exoskeleton was created to limit the movement of a spasm in both the horizontal and vertical directions. The final product of this project was intended for possibility of everyday use. A total of 40 trials were ran testing the force exerted with and without dampers at two different angles. The exoskeleton was attached to a vertical wooden stand, a force probe, and 800 grams of weight. These were used to simulate a spastic jerk of an arm and to test how the exoskeleton could limit the velocity of the simulation. The data of the forces exerted were recorded in a table in Excel and a two-sample t-test was performed to determine the significance. The test showed there was a significant difference, which

meant that a velocity limiting exoskeleton could help control the spastic movements of a child with cerebral palsy. The data in this experiment gave good insight as to how assistive, wearable robotics can help those with disabilities gain independence. With further research and more development, this exoskeleton could become a part of some people's everyday life.

### **The Effect of ABEC Bearing Grade on Velocity**

*Jake Bennett, Clover Hill High School*

### **The Effect of Wood type, Width, and Length on the Durability of Drumsticks**

*Seth Bliley, Chesapeake Bay Governor's School for Marine & Environmental Science*

### **Different Projectile Materials Affecting Propulsion in a Prototype Electromagnetic Projectile Launcher**

*Ross Brown, Southwest Virginia Governor's School*

### **The Effect of Various Materials on the Rate of Temperature Increase and Energy Output of Solar Cells**

*Hunter Bowles, Central Virginia Governor's School for Science & Technology*

In this research project, a study was conducted to find if there was any statistically significant difference between the rates of increase in temperature in solar panels by using a coating of yellow petroleum jelly, more commonly known as Vaseline, or an aluminum heat sink. To do so, panels were tested in three groups: control, Vaseline, and aluminum, under a heat lamp to simulate sunlight at a local high school. These tests ran for thirty minutes each, and data was collected on both the changes in temperature using an infrared thermometer and voltage output using a LabQuest 2 with voltage probe. After testing was completed one-way ANOVAs were run on each set of data to find any significant difference. As the alpha value of .05 was lower than the p-values of .24 (temperature) and .13 (voltage), the research hypothesis that the Vaseline would improve the panels greater than the aluminum was not supported. In conclusion, neither the Vaseline nor the aluminum foil produced a more significant improvement to the panels than the other.

### **Developing an Unmanned Solution for Wetland Observation**

*Gavriel Cambridge, T. C. Williams High School*

### **An Autonomous Quadcopter for Urban Search and Rescue**

*Owen Cardwell and Brendan Doney, T. C. Williams High School*

In recent years, the human fatalities and financial loss associated with urban search and rescue missions have increased; however, the complex terrain and faulty connection that characterize such environments make it difficult for robots to supplant humans. In this project, an autonomous system for a LiDAR-equipped quadcopter was developed for high mobility and awareness to have repeatable autonomous flight that progressively increases in speed. The Beta flight control software and firmware were used to test the hardware on the quadcopter initially, with a subsequent shift to the ArduPilot firmware for autonomous control. Ubuntu MATE 16.04 and Robot Operating System were installed on

a Raspberry Pi to act as a coprocessor. After setting up the basic systems, three test flights were performed to test the accuracy of the ArduPilot feature set. In the three flights, the quadcopter moved progressively closer to a successful altitude hold, but a crash in the third flight snapped an arm on the quadcopter. To then subvert the need for a physical rig, an environment was simulated using the model quadcopter and indoor flight environment of the ROS package hector-quadroter. General functionality was verified using manual control and waypoints were selected for the development and testing of autonomous code. In the end, the project did not meet its goals, but it was successful in limited autonomous flight. The primary limitation was simply the inconsistency of the physical drone, as it resulted in damage that forced the switch to simulated testing late in the development cycle.

### **The Effects of Elliptic Curve Cryptography on the Efficiency of Consumer Grade Backup Encryption**

*Nicholas Cooney, Southwest Virginia Governor's School*

### **Building a Better Servo Gear**

*Roman Cutler, Chesapeake Bay Governor's School for Marine & Environmental Science*

Gears transfer energy from electric motors to mechanical mechanisms and are used in industries and in everyday use (such as car windows, hard drives, microwave ovens, and smartphones). Gears are composed of different thermoplastic materials (nylon, being the most common). This study tested the shear stress and longterm wear of different types of thermoplastics to determine the most reliable, wear resistant, and cost-efficient material. Different thermoplastics including POM, PETG, ABS, PLA, and nylon were tested. Gears were created using the g-code from the "Pro Gear" shape generator in Tinkercad and a Monoprice Select Mini 3D Printer with a 0.3mm brass extruder nozzle. A pneumatic piston was used to determine the shear strength of the plastic gears. There was a significant difference between the shear stress of materials (p-value of  $1.29 \times 10^{-6}$ ) with PLA gears having the highest shear stress and nylon the lowest shear stress (PLA > POM > ABS > PETG > nylon). The results of the study suggest that other thermoplastics, specifically PLA, may be more reliable and resilient than nylon and can provide a less expensive thermoplastic option for servo gears.

### **The Effect of Alternative Reinforcement on Concrete Beams**

*Nolan Dawson and Beatrice Savarie, T. C. Williams High School*

In this experiment, we tested different materials as concrete beam reinforcements. The objective of our project was to see what cheap, accessible materials could possibly reinforce concrete beams. The materials that were tested were steel, bamboo, rope, t-shirts, and corn stalks. Our hypothesis was if steel is compared to other reinforcements in concrete beams, then it will perform the best because steel is much sturdier than the other reinforcements and will help the concrete beam resist the load. After securing the reinforcements into the molds, we mixed the concrete with water and poured it into the molds. Once the concrete was dry, we removed the beams from molds and let them fully harden. Finally, we went to a lab at George Washington University to test the strength of the beams. The beams were tested in a compression test. A load was put on the center

of the beam, and the load increased until the beam yielded. Our results showed that steel was most successful in strengthening the concrete, as predicted. Rope came in second, t-shirts in third, then bamboo, and corn stalks in last. We concluded that steel is the best material for reinforcing concrete beams. Rope, t-shirts, bamboo, and corn stalks all failed to strengthen the concrete; instead, they just held the concrete beam together. These reinforcements would fail to support any large load however, they were successful in keeping the beam together after the beam broke. The overall goal of this project was to test different materials that could possibly be used to reinforce concrete beams in countries that might not be able to afford steel reinforcements.

### **Parallel Parking Device**

*Adam Downs, Southwest Virginia Governor's School*

The difficult act of parallel parking is a source of stress and fear for many drivers. Car manufacturers have realized this and to alleviate the issue have added helpful features to some of their vehicles such as automated parking. However, these options are limited by their accessibility. Many vehicles possess a 2" by 2" receiver hitch, so to make easy parallel parking more accessible a device was constructed that could be inserted into this hitch. The device was a deployable continuous track that allowed lateral movement of the rear of the vehicle. It was tested to determine if it could make the vehicle fit in a smaller space than the regular method, as this would allow more room for driver error. A fake parallel parking spot was constructed out of barrels and wooden 2x4s and was placed on a total of 5 surfaces, being mud, dirt, snow, gravel, and pavement. Two sample groups, one with the device and one without the device, were tested on each surface. The barrels started far apart and were moved closer together each time the group being tested was able to successfully park between them while meeting certain conditions. In each of these 5 trials, the sample group with the device was able to fit in a smaller space than the sample group without the device, and a two sample t-test revealed that there is enough evidence to suggest that the group with the device is able to fit in a smaller space. This in turn suggests that the device makes parallel parking easier, which could entertain the possibility of retrofitting old vehicles with new technologies instead of producing new vehicles to save money and resources.

### **Effect of Lightweight Concrete Additives on the Weight and Load Bearing Capacity of Concrete**

*Andrew Dunlop, Central Virginia Governor's School for Science & Technology*

The purpose of this project was to improve concrete by reducing its weight while trying to maintain similar compressive strength. This study was conducted at a local engineering firm. Carbon fiber, steel wool, shredded plastic, and Styrofoam, were all added to a bagged concrete mix in a ratio of 2 percent by volume. The mix was then poured into PVC pipe molds and were left to cure for either 21-days or 28-days. The molds were then removed, and the concrete cylinders were crushed by a mechanical press to determine the maximum load they could take. The inferential test used on the data was a two-way ANOVA with replication. The p-values for the 21-day test, 28-day test, and the interaction between were all below the alpha value of .05 showing significance. The p-values were  $3.98 \times 10^{-7}$ ,  $1.5 \times 10^{-3}$ , and  $1.28 \times 10^{-7}$  respectively. The control group performed best for the 21-day samples, but for the 28-day samples, the Tukey test showed that the steel

wool mix and the control group may be in the same population of means. The research hypothesis that carbon fiber would have the lowest weight to strength ratio was not supported by the data. The experiment concluded that adding materials to concrete lowers the strength and does not decrease the weight significantly.

### **Comparing Agro-waste Products from Corn, Rice, and Hemp for Use in Thermal Insulation**

*Armelle Duston, Central Virginia Governor's School for Science & Technology*

The purpose of this research was to determine the effectiveness of common agricultural waste products as thermal insulation by comparing them to conventional insulation. An incubator was used to heat the three test groups, hemp fiber, corn cob, and rice hulls, in a small box for 12 hours at 50 degrees Celsius. The change in temperature was measured for each group as well as the control groups, fiberglass and no insulation, and the outcomes were compared. The average changes in degrees Celsius for hemp, corn, rice, fiberglass, and no insulation were 20.6, 17.6, 16.2, 17.2, and 21.4 respectively. An ANOVA was performed giving p-value of 7.46E-13 which was compared to an alpha value of .05. A follow up Tukey Test then indicated that corn and rice behaved similarly to fiberglass insulation while hemp behaved similarly to no insulation. The research hypothesis predicted that these agricultural waste products would perform similarly to conventional insulation. The hypothesis was partially supported because two out of the three groups did so successfully. This research indicates that rice hulls and corn cob have thermal properties which make them good potential insulation materials, especially in places where people are living in poverty and do not have access to conventional options.

### **The Effect of 3D Printing Infill on Strength**

*John Evans, Yorktown High School*

### **An AI-based System for Discovering Potential Adverse Drug Events Using Open Data**

*Brandon Fan, Blacksburg High*

According to the U.S. Department of Health and Human Services, adverse drug events (ADEs) account for one-third of total hospital adverse side effects every year equating to 45 million people per year. The increasing prevalence of health social media platforms—such as WebMD, Health Board, Drugs.com, Drug Bank, open FDA, and Unified Medical Language Service (UMLS)—offers a promising direction for ADE identification and extraction from online patient self-reports that usually predate Federal Drug Administration reports and notices. However, prior ADE extraction models, attempting to utilize this data source, often utilize a lexicon-based keyword matching approach, which cannot accurately and comprehensively extract ADE information. In addition to the ADE problem persists in the problem of classification. Not only do ADEs need to be properly extracted, but also properly classified for doctors and physicians to produce an accurate assessment of drug performance. This research proposes a novel AI-based system for ADE identification, extraction, and classification, properly called Drug AID+. By using comprehensive multi-source features from both word embeddings and pre-trained models as input, the ADE extraction approach learns useful features for ADE recognition. The ADE classification model combines the power of machine learning coupled with an

n-gram analyzer to beat state of the art classification techniques. The experimental evaluations demonstrate that both models can outperform existing models by a large margin. This system can be applied to multiple healthcare tasks and ultimately solve the problem that doctors face when prescribing drugs. In addition, this system introduces a novel method for an online platform for medical democratization.

### **The Effect of Wind Turbine Spacing on Power Output**

*Matthew Ganser, Central Virginia Governor's School for Science & Technology*

The purpose of this experiment was to determine if the amount of wind turbine power production lost due to the wake effect decreased as the distance between turbines increased. This study was conducted at a local high school during November and December of 2018. Energy production was recorded of a scaled down turbine in megawatts in wind simulated by an industrial fan both when it did and did not have a turbine in front of it simulating the wake effect. Different realistic distances were tested, and the difference in power production caused by the wake effect of the front turbine was found, which was then used to compare the amount of production lost to distance. The data was analyzed with a two-factor ANOVA test and produced an F-Value of 2.05035, while the F-critical value was 2.20855. This meant that the data was statistically insignificant and the null hypothesis, which is that the distance between the two turbines generating and suffering from the wake effect did not affect the amount of power production that was lost, was retained. Therefore, increasing distance does not have a statistically significant effect on the amount of power production lost due to the wake effect.

### **The Solar Power Gauntlet**

*Neil Gascon and Alan Gonzalez, T. C. Williams High School*

In our project, we created a circuit that utilized a solar panel to charge a fan to provide air conditioning to people through eco-friendly means. The purpose of our project was to create a product that would satisfy a human need of cooling off in hot weather, while also being environmentally friendly and easily transportable. Our procedure was divided into four phases, the first three relating to the construction of the cardboard arm, with the last phase having to do with testing the product in order to determine its effectiveness. Each step was taken in each phase was taken in an attempt to satisfy the laid out goals. In addition, we created six goals that could be used to determine the effectiveness of our product. Our first and, currently, our only design utilized a car charger in order to connect the USB fan and the panel. While this process worked, the results recorded were far from what was expected in a negative manner. Upon the completion of all four phases, our product only failed one goal: the fan's lifespan after being charged by the solar panel. This was due to us acquiring a weak solar panel; subsequently, when this solar panel was charging the fan, it only absorbed small amounts of sunlight. This project will be continued through modifications to the gauntlet that will hopefully make the fan efficient for practical use. The end goal of our project is to create a circuit for the fan that has a charging time equal to or less than the amount of time the fan stays powered on before dying.

### **The Effect of Various Materials on the Efficiency of Wireless Charging**

*Caleb Grohs, Central Virginia Governor's School for Science & Technology*

This experiment was conducted to identify a material that, when placed over a wireless charging setup, increased the efficiency of the power transfer. The setup used in this experiment included a wireless charging pad with an independent wireless charging receiver coil. This coil was laid onto the charging pad and a broken phone was placed over it to make the results more applicable to a real-life situation. Then, various materials (acrylic, copper, silicon, and steel) were placed on the phone, with 10 trials per material. The voltage was monitored using a voltage probe during testing to compare the voltage output of the setup as the materials were changed. Next, the data was tested using a one-way ANOVA test and a Post-hoc Tukey test. The ANOVA test revealed a p-value of .00058 and suggested a statistically significant difference when compared to the alpha value .05. These results were run through a Post hoc Tukey test with a D min of .06022. This test revealed that the control group and all other groups were statistically significant when compared to the steel group. The data did not support the research hypothesis, since it was hypothesized that the silicon group would have a statistically higher voltage output when compared to the control group. Although this experiment did not identify a material that increased the efficiency of the wireless charging setup, the results can be used to design wireless charging friendly phone cases.

### **The Effect of Type of Uniform Convex Polyhedra on Industrial Strength**

*Lillian Hallock, Mills E. Godwin High School*

## **Engineering B**

### **The Effect of Different Amounts of Pure Graphite Powder on the Thermal Conductivity of Geothermal Heat Pump Grout**

*Charles Hamilton, Mills E. Godwin High School*

The purpose of this experiment was to determine the effects of different amounts of pure graphite powder (PGP) on ground source heat pump (GSHP) grout thermal conductivity (TC). GSHP systems are wildly more energy efficient compared to other HVAC systems, and they can be used to help transition our society into one that strictly uses renewable energy. Grouts with a higher TC allow for a cheaper installation, making the GSHP system a more viable option for consumers. Grouts were made by augmenting a base grout mixture with 0%, 5%, 10%, 15%, and 20% of PGP. The TC of these grouts were than tested using a custom apparatus. It was hypothesized that if the dry grout mixture consists of 20% PGP than that cured grout will have the highest TC. The results revealed that grouts made with 20% PGP had, on average, an almost three times higher TC than the non-doped grout. Statistical t-tests were done on the data and they revealed that the data was significant for seven of the comparisons but not significant for the other three. The results did support the research hypothesis. It is believed that the results are due to the fact graphite has a high TC due to the delocalized electrons contained in its molecular structure, its properties are translated into the grout. This research could lead to further studies that investigate doping GSHP grouts with different carbon allotropes.

### **The Measure of Data Rates and Signal Strength on the Reliability of the iBwave Software**



*Timothy Hannan, Central Virginia Governor's School for Science & Technology*

### **The Effect of Different Audio Compression Algorithms on File Size and Fidelity**

*Carl Hayden, Central Virginia Governor's School for Science & Technology*

The purpose of this study was to determine if there were notable differences between audio files' size and their respective fidelity. The project began by recording each file and converting them to three different file types (in addition to the control). From there, the audio program Audacity was used to record each of the audio level values for each file so that they could later be compared using Excel. In addition, human participants from a local high school and business office were asked to determine if the various files were discernible by ear. After performing four one-way Analysis of Variance (ANOVA) tests, the end results for two variables supported the hypothesis, while one did not. The p-values were .299, 3.1E-09, 3.3E-05, and .72 for the Piano, Chicken, and Voice audio clips with the fourth being human participant data. The p-values for the Piano test and human data were greater than the alpha value of .05. However, the trials with the chicken and voice audio clips were statistically significant. Following the initial ANOVA testing, post-hoc Tukey tests for the Chicken and Voice audio clips, discovered that the .wma file algorithm was the only one statistically significant across both trials. In conclusion, the audio compression algorithm had no significant effect on the file size compared to fidelity.

### **Hydroponic Gardening: A Solution to Limited Produce Production in Urban Environments**

*Savannah Keough, T. C. Williams High School*

To feed the growing population, alternative food production methods for urban environments are needed to augment traditional agriculture. Two hydroponic systems were constructed, one horizontal and one vertical, to determine which system could grow 40 lettuce and 40 kale plants with more height, mass, crispness, and a brighter color. The horizontal system was designed so plants floated on water, and the vertical system so water to ran down over the roots of the plants. In conclusion, the lettuce and kale plants grew better in the horizontal system because the plants could regulate their water intake, which was not possible with the constant water flow in the vertical system. After the lettuce and kale were grown, 80 microgreens were tested to see if it was the system or the plants that resulted in better growth. In conclusion, the microgreens grew well in both systems, but slightly taller in the horizontal system. For all plants grown, the horizontal system was the ideal hydroponic system for indoor plant growth. The next steps are to test the systems with more plants and experiment outdoors.

### **Using a Neural Network to Identify Invasive Species of Fish**

*Noah Khan, T. C. Williams High School*

The purpose of this project was to determine if invasive species in the Chesapeake Bay Watershed could be quickly identified using a neural network. Four goals were developed to test success; identify subjects with at least 90% confidence, in under five minutes, from an image from pictures above the water, or of fish taken out of water. To construct the neural network, Python 3.6 was installed along with pip, Numpy, Keras, Tensorflow, and Virtual Environment. A folder was filled with hundreds of pictures of invasive (Northern Snakehead, Blue Catfish, and Rusty Crayfish) and native species (Bluegill, American

Shad, and Largemouth Bass). Using a Python editor, codes were run to retrain the neural network. Using three pictures of each species, the network was tested. With few exceptions in confidence, all the goals were achieved. To reduce the potential for false positives, the network was further trained on objects that were not fish. The network was able to correctly identify vehicles, land animals, and people as not fish with at least 90% confidence. For the plant images unfortunately, none of the trials were able to produce an above 90% confidence. To increase the confidence levels in both plants and fish, many more training images must be included during retraining. A future goal for this project is to convert this laptop based neural network into a phone app for field use so that if people catch an unknown fish, they can check if it is invasive or not.

### **The Effects of Track Spikes on Running Time**

*Jeremy Kraisser, Chesapeake Bay Governor's School for Marine & Environmental Science*

In this experiment, the quantitative effect of track spikes on running time was measured. Volunteers were split into even groups and equipped with differing footwear, one group with normal running shoes and the other with track spikes fitted with needle spikes of 3/16". They ran three laps of the track, stopping for rest in between each, while being timed and regulated, before leaving and returning the next day for another trial, switching footwear. While a p value was found that signified less than a significant difference, the value was still lower than .10. In the experiment, it was found that the average time with track spikes was less than the average time in running shoes. While there was a decrease in time noted with the track spikes, it was not a fully significant difference.

### **Modeling the Effects of Shoreline Engineering Structures on Shoreline Erosion**

*Calvin Kramer, Chesapeake Bay Governor's School for Marine & Environmental Science*

Climate change is an immediate threat to coastal communities, as greenhouse gas emission increases, the atmosphere warms up. Over the past Century about 70% of the world's beaches have retreated (Bird, 1993). As a result, shoreline engineering structures have been created to minimize the impact of the wave action on the shoreline erosion. The implementation of shoreline structures is a step in the process of resilience. The purpose of this study is to determine on a small scale which shoreline engineering structures provide the least amount of shoreline erosion. A mock beach was created in a wave tank, waves were created for 5 minutes and then the change in sand height was measured. There were 6 Shoreline engineering structures tested during the study, 3 on-shore, 3 off-shore. The data showed the best shoreline structure to mitigate shoreline erosion was the off-shore riprap and the off-shore sea wall. However, the perfect solution is more complicated than just one independent shoreline structure. The most effective shorelines structures are multiple types of structures used together, the ideal option is a hard off-shore structures like riprap or sea wall and a soft on-shore structure likes a living shoreline. However, the cost and environmental impact of the shoreline engineering structures must be considered. Therefore, the cost and benefits of each structure must be weighed, and the best decision made.

## **The Effect of a 45-degree Windward Wall on the Damage Caused by Hurricanes**

*JT Lotz, Central Virginia Governor's School for Science & Technology*

The purpose of this experiment was to find a way to help mitigate damage done by hurricane winds. Three groups of model houses made of cardboard held together by gorilla glue were constructed, and a 45-degree wall was attached to the roofs of one of the groups. Then two of the groups, including the ones with the attached walls, were subjected to 15 minutes of wind produced by a leaf blower representing hurricane winds. After being subjected to wind, all three groups had weights stacked on top of them until their walls failed, and the amount of mass it took for the walls to fail was converted and recorded in terms of kPa. A single factor ANOVA test was run and produced a p-value of .00146 with an alpha value of .05. A Tukey test with a minimum difference of 9.54 kPa, calculated with a  $Q_t$  value of 3.61, showed a significant difference was found only between the no wind control and the other two groups, not between the wind control group and the experimental group. The experiment did not support the hypothesis that adding a 45-degree windward wall would reduce damage done from hurricane winds. The results suggest that adding a 45-degree windward wall does not affect the damage done from hurricane winds, and that other mitigation practices must be developed.

## **The Effect of Different Cooling Devices on CPU Temperature**

*Sean Mapes, Central Virginia Governor's School for Science & Technology*

The purpose of this study was to determine if different CPU cooling methods had an effect on the temperature of the processor at maximum and idle loads. The hypothesis was that if the water cooler was used, the temperature would be decreased more than every other cooler involved. Three cooling methods were used in this experiment; a stock control cooler, a passive air cooler, and a water-cooling loop, which were each individually installed onto the processor. Twelve trials were run for each cooling method, with temperature being recorded for each. A two-way ANOVA was used and resulted in a p-value of  $3.1900E-51$  and an alpha level of .05. This showed that the data was significant, and this supported the original hypothesis, that the liquid cooler would provide the most effective heat removal. The results suggested that cooling methods involving liquid are effective for removing heat from processing chips.

## **The Effect of the Angle of a Rudder on a Paper Glider on the Landing Angle**

*John Matuszewski, Washington-Lee High School*

## **The Comparative Tensile Strength of Two Chainmail Weaves**

*Jadelin McLeod, Harrisonburg High School*

A wide variety of chainmail weaves have been used by different groups throughout history as protective armor. Because chainmail continues to be incorporated in modern protective garments, it is relevant to explore and compare the mechanical properties of different weaves so that modern designs can incorporate the weave best suited for its purpose. In this paper, the tensile strength of handmade chainmail samples representing two weaves (Japanese 4-in-1 and European 4-in-1) as tested with an INSTRON machine were compared. The numerical results from the tests were compared using a two-tailed t-test. It was concluded that because there was no significant difference in yield stress, first

fracture stress, or ultimate stress between the two weaves, Japanese 4-in-1 and European 4-in-1 do not differ in tensile strength.

### **The Effect of Medical Casting Materials on Force Absorbency**

*Spencer Morrison, Central Virginia Governor's School for Science & Technology*

The purpose of the research conducted was to identify effective medical casting materials. An impact pendulum was used to test the shock absorbance of each material because the more force the material absorbs, the less force the bone absorbs, which speeds up the recovery process. After examining the force absorbent qualities of Fiberglass, Acrylonitrile butadiene styrene (ABS), Noryl, and Sorbothane, the data showed that Sorbothane and Noryl absorbed the most force. After performing a post-hoc Tukey Test, the data showed statistically significant differences between every group except Sorbothane and Noryl. Fiberglass absorbed the least amount of force compared to the experimental groups. The research was found to be statistically significant after performing a single-factor ANOVA test. The resulting p-value of  $5.79 \times 10^{-31}$  was lower than the alpha value of .05. The research hypothesis, "If alternative medical casting materials are used, then they will show more force absorbent qualities than fiberglass and therefore be more fit to be used as a casting material," was supported. Sorbothane and Noryl products could truly change the way casts, helmets, shin-guards, and protective equipment are produced.

### **The Effect of Cable Materials on the Grip Strength of a Prosthetic Hand**

*Bryan Polk, Central Virginia Governor's School for Science & Technology*

The purpose of the research was to identify a cable material that would increase the grip strength of a prosthetic hand. Three prosthetic hands were made using Kevlar, fluorocarbon, and Spectra as cable materials. Each hand was closed on a hand dynamometer and the maximum force was recorded. The mean force for Kevlar was 8.71 Newtons, fluorocarbon was 9.3 Newtons, and Spectra was 10.6 Newtons. A one-way ANOVA test was conducted; the p-value was .00462 and the alpha value was .05. Then a Tukey test was done and there was a statistically significant difference between Spectra and Kevlar. The research hypothesis, "If different cable materials are used in a prosthetic hand to grasp a hand dynamometer, then Kevlar line will be able to grip with the most force," was not supported by the data. The significance between Spectra and Kevlar shows that Spectra increases grip strength when compared to Kevlar.

### **Reducing Lithium Ion Battery Fade in Phones**

*Fernando Posada and McGrath Seamus, Harrisonburg High School*

### **The Effect of Thermal Conductivity in Metals on Thermoelectric Power Generation**

*Carynne Posey, Central Virginia Governor's School for Science & Technology*

The purpose of this study was to determine the effect of thermal conductivity in metals on the performance of a thermoelectric circuit. The research hypothesis stated that if a metal has a high electrical conductivity and a low thermal conductivity, then its voltage output will be high. Two types of metals were compared in this study, aluminum and copper. These metals were used along with steel wire to make aluminum/steel and copper/steel thermocouples to be compared. The thermocouples were heated over a burner to

produce a voltage through the thermoelectric effect. After 20 seconds of heating, the voltages were recorded with a multimeter. A two-sample t-test was performed to determine significance, which returned a p-value of  $4.3495 \times 10^{-11}$  with an alpha of .05. This showed that the data was significant, and the research hypothesis was supported. Overall, the results suggested that a low thermal conductivity produces a higher voltage in a thermoelectric circuit.

### **Different Protective Coatings Effect at Maintaining Elastic Limit of Aluminum Post-Gallium Penetration**

*Justin Schoeneweis, Central Virginia Governor's School for Science & Technology*

The purpose of this study was to determine if a certain type of protective coating affected the elastic deflection of aluminum 6061 metal after being exposed to gallium. The hypothesis was that between my three coatings, if WD40 corrosion inhibitor was used as a coating, then it would be the most effective at maintaining the aluminum's original tensile strength. Five groups were used in the experiment; two controls (one with gallium exposure and one without), ProtectaClear coating, Everbrite coating, and WD40 Corrosion Inhibitor. Five samples per group were exposed to gallium after the coatings were applied and set to dry for 24 hours. Elastic Deflection was determined by using a tensile tester housed in a local lab and then determined where elasticity was completely lost. A one-way ANOVA determined significance, with a p-value of .31 and an alpha level of .05. A post-hoc Tukey test was not necessary to conduct due to my data not being statistically significant. The results did not support the original hypothesis that if WD40 Corrosion Inhibitor was used as a coating, it would provide the most protection from the gallium penetration. The results suggested that the protective coatings or gallium did not have any effect on the tensile strength of the aluminum post-gallium penetration.

### **Solar Airframes: What is the Most Aerodynamically Efficient Design?**

*Aaron Vickers, Southwest Virginia Governor's School*

Solar powered aircraft have the capability to revolutionize many industries. Operating as pseudo-satellites, they can fly for months at a time while conducting surveillance, telecommunication operations, and more. A fundamental issue with the development of these aircraft, however, is the airframe. Within the field, it is still undecided what the optimal general airframe is for use with solar powered aircraft. By using rapid prototyping software alongside fast simulations, this may be remedied. The researcher proposes a generalized airframe that, for a given wingspan, should have a higher lift to drag ratio than other general designs. This generalized airframe, due to its improved lift to drag ratio, should allow for increased efficiency under conditions usually experienced by solar powered aircraft. The airframe was designed using Open VSP and its paired vortex lattice solver, VSPAERO. After many different design cycles, an improved general airframe was developed that had an approximately 5.2% increase in its lift to drag ratio when compared to the previously most efficient design.

### **The Effectiveness of Acid Resistant Paint in Protecting Wood from Acid Corrosion**

*Christopher Webb, Central Virginia Governor's School for Science & Technology*

The purpose of this study was to determine the effectiveness of various types of paint in preventing corrosion from simulated acid rainfall to determine the optimal paint treatment to prevent acid corrosion. The research hypothesis was that if wood was significantly corroded by soaking in acid, then wood coated in acid resistant paint with an enamel base would be more resistant to acid corrosion than any other treatment. There were four groups, each with fifteen wood samples, used for this experiment: one coated in oil-based paint, one coated in enamel-based paint, one coated in paint with no active corrosion-resistant ingredients, and one unpainted (control) group. 1000  $\mu\text{m}$  of sulfuric acid, pre-diluted to a pH of 3.5, was applied to each of the samples once a week over the course of four weeks. The thickness of the samples was measured both before and after the application of simulated acid rainfall. A one-way ANOVA revealed a significant p-value of .0016 ( $\alpha=.05$ ) and a post-hoc Tukey test provided a D min value of .0015 which revealed the differences to be solely between the control group and the other groups. These results enabled the rejection of the null hypothesis that there would be no difference between the paint treatments, but the results did not fully support the research hypothesis. Essentially, the results indicated that the application of a paint treatment has a significant effect in preventing acid corrosion, but that no particular paint is significantly better than any of the others.

### **Comparison of the Thermal Properties of Different Roof Materials**

*Matthew Wiechman, Chesapeake Bay Governor's School for Marine & Environmental Science*

Asphalt shingle roofs have low albedo and cause the internal temperature of homes to be greater, which causes air conditioners to use more energy. Air conditioners use about 6% of the electricity in the United States, and alternatives to asphalt shingle roofs could reduce energy consumption for air conditioning. This study examines the performance of green, metal, and asphalt shingle roofs to determine the potential energy benefits available from these alternatives. To measure the difference in insulation by varying roof types, three identical houses were constructed and placed next to each other, so that the internal and ambient temperature of each house could be recorded daily over a 6-month season, comparing performance from summer to early winter. The average temperature comparison between the asphalt shingle, metal, and green roofs using ANOVA yielded  $p < 0.05$ . This statistically significant difference means that the hypothesis  $H_1O: \Delta\text{TempGR} = \Delta\text{TempMR} = \Delta\text{TempASR}$ , can be rejected, green roofs are significantly better than metal and asphalt shingle roofs at keeping homes cooler. Initial cost is a deciding factor for roof type, so if green roof costs decreased, more people might be willing to consider this choice to reduce energy demand and CO<sub>2</sub> emissions.

### **Flexural Strength of Beam Structures**

*Dilin Williams, Washington-Lee High School*

The experiment investigated the flexural strength of balsa wood sheets with cut-outs of different shapes in an effort to find the most effective method of reducing the weight of a structural piece. A total of 4 different designs were tested. Ten trials were conducted for each design. When conducting a trial, the sheet being tested was placed in a testing apparatus that used a bucket of sand hung on the end of a lever to apply downwards force. The different designs tested were square cut-outs, circular cut-outs, triangular cut-

outs, and no cut-outs. The sheets with no cut-outs were cut to smaller dimensions to match the mass of the other designs. It was hypothesized that the circular cut-outs would have the highest breaking force of all of the tested designs. The results of the experiment showed that the circular cut-outs had the highest mean flexural strength, closely followed by the control. However, the design with circular cut-outs was wildly variable, and no significant difference was found between it and the control. This result was likely caused because the cut-outs created points of stress, making them easier to break. The experiment confirmed that the most effective way to reduce the weight of a structural member is to reduce the overall size of the part, rather than cut pieces out of it.

### **SimpleChIP: A Microfluidic Device for Accessible ChIP-seq**

*Alice Xu, Blacksburg High School*

Chromatin immunoprecipitation (ChIP) is the only experimental method used to profile epigenetic changes due to histone modification. However, the process is both time and resource consuming, while procuring data in a very low throughput fashion. Microfluidic technologies are already being used to increase throughput by running many low-input experiments in parallel, at a smaller scale, which allows for lower resource usage and more direct control of the experiment. Microfluidic ChIP is additionally adaptable to computerized systems, which reduces manual handling. Of the current methods, many are exceedingly complicated and require many months of training to use. This is inefficient for use both commercially and in medical laboratories. Simple-ChIP seeks to ameliorate this issue by utilizing a fluidized-bed microfluidic platform with all washing solutions loaded in by a single inlet source with a custom-designed computer program. The results yielded for ChIP analysis of histone modification H3K4me3 at low-input cell concentrations indicate decent correlation with the ENCODE standard database, supporting SimpleChIP as a viable ChIP alternative and further study into its development.

## **Engineering and Technology A**

### **The Effect of Different Colored Light Bulbs on Distance Traveled by a Solar-powered Robot**

*Lily Allen and Ellie Potts, Swanson Middle School*

The project was the effect of different colored light bulbs on the distance traveled by a solar-powered robot. The intention for this project, or how to apply this to real life was not to prove that current solar panel technology is going in the wrong direction, but to show that the methods used now are ideal. The current technology used today, involves direct sunlight (which is perceived as white) hitting photovoltaic cells and producing energy. Some examples of how knowing this can help are, powering electricity in common buildings like houses or office spaces. This can save everyone from the reliance on non-renewable fossil fuels. The experiment was tested using different colored light bulbs, to prove that the current method of producing solar energy was superior to other options. You can see through the data that white light, which is the control, is the way to go. White lights average was 73.4 cm which is a large distance away from our 2nd place, which was red light at 52.7 cm, followed by blue at 49.1cm, and green at 48.9 cm

respectively. It can be assumed the data came out this way based on the research of the color spectrum.

### **The Effect of Bridge Design on Bridge Strength**

*Eyuel Berhanu, Thomas Jefferson Middle School*

The purpose of this study was to analyze the effects of bridge design on bridge strength. The independent variable was the type of bridge. The experimental group included these levels: girder, truss, arch, cable-stayed, and the researcher's hybrid design. The dependent variable was the amount of force the bridge can withstand without breaking. The constants were: bridge span, height from ground, type of building material, glue type, and amount of individual building materials used. There was no control group. The hypothesis was: If a weight is added to different bridges, the truss bridge will hold the most weight without collapsing. Five bridges were placed in between 2 level surfaces and tested. Sand was gradually added to the bucket, and the final weight (converted to Newtons) was measured and recorded after the bridge could no longer withstand the force. The results showed that on average the truss bridge withstood the most newtons. These results show that the hypothesis was supported. In conclusion, the study suggests that bridges are a very reliable method to get from point A to point B, as long as the bridge is built correctly and the correct type of bridge is used, depending on the specifications of the project.

### **The Effect of Different Artificial Intelligence Technologies on the Accuracy on Recognition of Diseases**

*Anshul Chiranth, George H. Moody Middle School*

Artificial intelligence was first explored in 1955. John McCarthy, an American computer scientist, first coined the term in his 1955 proposal for the 1956 Dartmouth Artificial Intelligence Conference. Since then, huge steps in this field of technology have been made. Machine learning is the ability for a machine to learn information, without being programmed to know this information directly. Artificial intelligence is the overall field, in which technologists aim to create intelligent machines. Today, artificial intelligence plays a big role in peoples' lives. These intelligent machines aim to help humanity in every way possible, from teaching people to make a form of pasta, to providing the daily weather report. The purpose of this experiment was to find the most accurate Artificial Intelligence Technology at recognizing diseases and illnesses (using user provided symptoms), using an Acer Aspire E 15 laptop running Windows 10 version 1803. The artificial intelligence dataset named Symptom Disease sorting (created by Paul Larmuseau on the website Kaggle) was used during the experiment. This dataset prompts the user with three questions, asking the user what health problems (symptoms) he/she is experiencing. This specific dataset was the preferred dataset, as it was simple yet thorough with its questions. The accuracy of these browsers was found using the percentage of diseases and illnesses they recognized correctly. The four AI technologies used in this experiment were TensorFlow, Caffe, Keras, and Microsoft Cognitive Toolkit. The order from most accurate to least accurate was TensorFlow (100%), Microsoft Cognitive Toolkit and Caffe (90%) and Keras (80%). The results from this experiment supported the hypothesis that TensorFlow would be the most accurate.



### **The Effect of Bridge Design on Weight Held**

*Ryan Cohen, Thomas Jefferson Middle School*

The purpose of this study was to find the effect of different types of model popsicle stick bridges on the amount of weight held. The independent variable was the type of bridge. The experimental group included beam, truss, and arch bridges. There was no control group. The dependent variable was the maximum amount of weight held by the bridge. The constants included: surface condition, length of the bridges, supporting table heights, type of glue used, and surrounding environment condition. The hypothesis was: if different types of bridges are tested, then the beam bridge will hold the most weight. The researcher built two equally sized bridges of three different types (beam, arch, & truss) using just popsicle sticks and glue. After the bridges dried, the researcher placed the bridges one by one in between two equally surfaced chairs, 18 inches apart. Various weights were then placed on the bridge at 100 grams intervals until collapse. The results showed that the beam bridge did bear the most weight, and the hypothesis was accepted. In conclusion, the study suggests that model beam bridges are able to bear the most weight, at least when the distance is 18 inches apart. Arch bridges were found to not balance weight as well as the other bridges, and truss bridges seemed to be generally less sturdy than beam bridges. This study shows that cities that need short, sturdy, and inexpensive bridges should definitely consider using beam bridges.

### **The Effect of Bridge Design on the Ability to Hold Load**

*Caroline Colucia, Thomas Jefferson Middle School*

This study was conducted to test the effects of bridge design on the ability to hold load. The independent variable was the bridge design: Suspension bridge, Pratt Deck Truss bridge, and Cable-Stayed bridge. The constants in the study were: the type of weights used to add mass, the wood used, and the glue used. The dependent variable was the amount of weight the bridge could hold before collapsing. The hypothesis was: If weight is added to the Pratt Deck Truss, the Cable-Stayed and the Suspension bridges until they break, then the Suspension bridge will hold the most weight. This study is important because bridges are everywhere; therefore, being able to build the best bridge, the one with the lowest cost that holds the most weight, is important. The first step taken for the experiment was to draw the bridges on AutoCad. Next, the bridges were printed out on paper and thin wooden sticks were glued on top of the paper. Then all of the parts of the bridges were glued together and lastly the weights were placed on each bridge until it broke. The results showed that the Pratt Deck Truss bridge held the most weight. These results reject the hypothesis. In conclusion, the study suggested that Pratt Deck Truss bridges held more weight than the Suspension bridge and the Cable-Stayed bridge.

### **The Effect of Different Toothpaste on Stain Removal**

*Rachel Dai, George H. Moody Middle School*

### **The Effect of Heat on a Solar Panel's Efficiency**

*Leonardo Fall, Swanson Middle School*

### **The Effect of Different Shapes on Radar Visibility**

*William Frank, Kenmore Middle School*

Radar is used everywhere. It is used in everyday objects, but also in aircraft. Stealth aircraft have irregular shapes, so the researcher was curious as to what shapes are stealthy. In this experiment, a hypothesis—that out of a W shape, V shape, cylinder and crumpled cylinder, the effectiveness of their avoidance of radar would be V, W, cylinder and crumpled cylinder— was tested. A box was covered with black construction paper on the inside. Then a lux meter and flashlight were placed in the box. Light was used to represent radar due to their similarities. Each shape was placed in the box one at a time, the flashlight was turned on, and the measurement was recorded. This was repeated five times for each shape. I then averaged my measurements. The average lx reading of the W was 18.4 lx. The average lx reading for the V was 15.6 lx. The crumpled cylinder had a mean lx reading of 26.8 lx, and the cylinder had the highest average of 32 lx. This experiment shows that the V was the stealthiest shape, the W was the second, the penultimate stealthiest shape was the crumpled cylinder, and the least stealthy shape was the cylinder. This shows that geometric designs with angles that do not reflect towards the source will be the best at slipping by radar. Shapes with dull, flat, straight on heads will be the worse.

### **The Effect of Different Light Types on RGB Values**

*Elizabeth Knerr, George H. Moody Middle School*

### **The Effect of Propeller's Pitch Angle on its Efficiency**

*Devesh Kumar, George H. Moody Middle School*

The propeller is one of the most commonly used method of propulsion. Propellers are efficient and relatively cheap compared to other propulsion systems. Although they are very useful, they are not perfect. Propellers are usually limited to small, sub-sonic uses, unlike jet engines which can be used for large projects. But jet engines are expensive to maintain and manufacture. The purpose of this experiment was to find the optimum pitch angle to create a most efficient propeller. The research hypothesis was that if a propeller with a 48-degree pitch angle is used then the efficiency (voltage generated) will be the greatest. Four propellers were bent to 40 degrees, 43 degrees, 45 degrees, and 48 degrees. Each propeller was attached to a motor, which was being used as a generator. A fan was placed in front of the motor. When the fan was turned on, the propeller would start spinning. The propeller's movement made the motor rotate. A multimeter was attached to the motor to record the voltage generated by the propeller. The results were recorded in a table. Afterwards, a table and graph were created for the mean, median, and mode of the data. The voltage increased as the pitch angle increased. The voltage generated with the 48-degree propeller was the greatest. The voltage was the largest with the 48-degree propeller, thus the research hypothesis was supported. Therefore, propellers can be more efficient if their pitch is increased.

### **The Effect of the Shape of the Supports on the Amount of Weight Supported**

*Shorya Malani, George H. Moody Middle School*

### **The Effect of Different Sunlight Angles on the Power Produced by a Solar Cell**

*Ella McNally, Thomas Jefferson Middle School*

The purpose of this study was to determine if different sunlight angles have an effect on the amount of power produced by a solar cell. The independent variable was the angle of the solar cell. The experimental group included: 15 degrees, 30 degrees, 45 degrees, 60 degrees, 75 degrees, and 90 degrees. The control group was the angle at 0 degrees. The dependent variables were the amount of milliwatts, milliamps, and volts produced by the solar cell. The constants were the amount of sunlight the solar cells were exposed to, the number of solar cells per surface, and the size of the surface. The hypothesis was: If solar cells are set at different angles and exposed to sunlight, the angle at 90o from the sun's rays will produce the most power. Using a measuring rig, the solar cell, attached to cardboard, was angled at 0 degrees, 15 degrees, 30 degrees, 45 degrees, 60 degrees, 75 degrees, and 90 degrees. After 15 seconds, the volts and milliamps were recorded in a data table. The results showed that the closer the angle is to 90 degrees, the more power the solar cell produced. These results supported the hypothesis. In conclusion, the study suggests that houses with solar panels should angle them at 60 degrees or greater, if possible.

### **The Effect of Distance from Mobile Device on the Amount of Radiation Received**

*Nayan Mehta, George H. Moody Middle School*

The purpose of the experiment was to determine the distance at which mobile phone radiation is greatest and weakest. Thorough research was done in preparation of the experiment. Most objects are radioactive, including mobile cell phones. Radiation can be used for beneficial purposes, such as curing illnesses and diseases, or for destructive or negative causes. Radiation is always much stronger and more powerful nearer to the object rather than farther. This explains why the most damage done by a nuclear bomb occurs near the central point. The hypothesis stated, "If the distance away from the mobile device is decreased, then the radiation received will increase". The experiment was done by gathering 2 different phones, a timer, a radio frequency meter (Acoustimeter AM-10), a sheet of paper, a writing utensil, and a flat surface. The experimenter used two of the phones to call each other, and the other for timing. The RF meter was used to measure the amount of radiation received (in volts per meter). The experiment consisted of six levels of IV, which were distance intervals at 0cm, 5cm, 10cm, 15cm, 20cm, and 25cm. The dependent variable was the amount of radiation received. The results varied per distance interval, but the statistical mean for each distance were 0cm: 5.59 v/m, 5cm: 2.95 v/m, 10cm: 1.88 v/m, 15cm: 0.39 v/m, 20cm: 0.07 v/m, and 25cm: 0.05 v/m. After experimenting, it was concluded that the hypothesis was supported by the data. The data also supported the fact that the smaller the distance between two objects, the greater the amount of radiation transferred.

### **The Effect of Different Materials on the Functionality of and Friction Produced by an Arm Prosthetic**

*Akul Miriyala, George H. Moody Middle School*

Prosthetics have aged throughout history. Initially, they were simply wooden toes or hook hands that were worn for a sense of wholeness. Throughout the ages, they evolved to 'bionic' limbs that are almost as functional as our biological limbs. However, they still have their cons. They can have high friction rates, which can cause infections and make the prosthetic harder to move. They can also have low functionality which makes them jam

and not work at all. To build these prosthetics, the experimenter used a 3d printer to print the parts for the first two prosthetics (ABS and PLA filament). The experimenter then attached the parts together with screws, superglue, and wire. For the last prosthetic (PE) the experimenter simply made a thumb with attaching Lego bricks and adding foam for smooth movement, as Lego is only square shapes and cannot be made a prosthetic of. To measure friction, the experiment used a spring balance, and to measure functionality, the experimenter made the prosthetics flex repeatedly to see if the fingers would break/jam. Any gray areas were deemed not functional. The hypothesis for this experiment was if ABS is the most flexible, strong, and rough then it will be the most functional, but will have the most friction produced. The purpose of this research project was to find out which prosthetic materials produce the least amount of friction but are very functional to solve the cons of prosthetics, such as skin infections caused by excess friction and mental irritation caused by lack of functionality. The friction outcome of the ABS prosthetic was 5.03 newtons, spread was 4N-7N, for the PLA prosthetic it was 3.3 newtons, spread was 2-6N and for the PE prosthetic, it was 1.1 newtons, spread was .25-2N. The functionality outcome for the prosthetics was 100% for ABS, 85% for PLA, and 55% for PE. Finally, the hypothesis for this experimented was supported as ABS got the highest friction and functionality rates. Improvements are being made to the PLA prosthetic as it had data similar to ABS and its design is made for teens and adults, who are the bulk of amputees. Improvements to be made include but are not limited to: voice controlled and motorized movement.

### **The Effect of Different Tennis Racket Overgrips on its Permeability when Saturated**

*Kaushik Narasimhan, George H. Moody Middle School*

In professional tennis, even the slightest variation of the weight of an over grip can change the outcome of the match (Gallwey, 2015). There are two main sizes of tennis rackets that professionals use, but since there is such a small difference, no grip size changes are needed. This information is useful for the 1,814 professional Tennis Players and is also useful for the 1.2 billion people worldwide that watch or play tennis on a regular basis. The purpose of this experiment was to determine how different types of over grips, Babolat, Head, Wilson, Gamma, and Tourna, would affect their weight when saturated. Five ceramic bowls were filled with one-half liter of room temperature water. Each bowl contained one specific piece of over grip which was five Centimeters long. It was hypothesized that the Gamma Over grip would have the greatest mean percentage of weight change. When being submerged in the water, one plate was placed over it to make sure the over grip is fully submerged. Every hour, the plate was taken off to make sure the over grip was still fully submerged. The weight of the Gamma Over grip increased by an average of 510%, when it was fully submerged by water and exhibited the greatest mean percentage of increase. The data supported the research hypothesis that the Gamma Over grip would have the greatest percentage of increase. The Gamma Over grip contains the most amount of composition, and its high levels of the composition may have allowed it to absorb that much water. Further studies can be done on the effect of different temperatures of water on the weight of tennis over grips when saturated. Further studies could be done using different brands of over grips while using the same procedure as this project.

## **Engineering and Technology B**

### **The Effect of Aluminum Fin Density on Heat Dissipation**

*Siddhant Prakash, George H. Moody Middle School*

Heatsinks are devices, generally made from metals such as copper and aluminum, that dissipate heat from a source and operate using the Laws of Thermodynamics. These laws explain how they are able to effectively transfer and dissipate into surrounding fluid through conduction and convection. They use heat fins to increase the surface area available for convection increasing heat dissipation; however, when too there are too many heat fins in a heatsink, airflow becomes restricted and heat dissipation decreases. The purpose of this experiment was to determine the number of ideal number of heat fins between no heat fins, 2 cm spacing, 1 cm spacing, and  $\frac{1}{2}$  cm spacing between each fin. A thermometer was suspended behind the heat sink, which was placed on a heat plate set to 230°C, and measured the air temperature, and in turn, the amount of heat being dissipated. The results indicated that the  $\frac{1}{2}$  cm spacing dissipated the most heat, heating up the air to an average (mean) of 29.81°C. A t-test performed on the data indicated a significant difference between the means of the levels and the control at a 99% certainty (t-stat = 2.50 > 2.62; t-stat = 19.27 > 2.62; t-stat = 19.44 > 2.62). This data supports the research hypothesis each level dissipated a significantly significant different amount of heat. Though other research indicates that an excess of heat fins can decrease airflow and limit heat dissipation, this experiment shows that even  $\frac{1}{2}$  cm spacing is not bounded by airflow. To further reinforce these findings, further experimentation involving even denser heat fin spacing would have to be conducted.

### **The Effect of Gear Ratio on Torque in Arduino Based Robots**

*Harini Ramaswamy, Swanson Middle School*

The basis of this experiment was the effect of mechanical advantage of the Arduino based robot on the number of centimeters the robot can travel in one minute, the number of centimeters the robot can push the wooden block in one minute, and if the robot can climb up a ramp and if so how far it goes. I wanted to study the results of various challenges the robot had to face and how the specific small to large gear ratio could handle three different mechanical advantage tests. I hypothesized that if the robot has a small to large gear ratio, then the robot will perform the best when it has to climb up the ramp, also known as torque, because the gear ratio is beneficial for torque in robots. I wanted to test the reliability of that gear ratio and how it could perform using the base structure for the robot that I had constructed although I knew that the gear ratio might not perform to its full potential utilizing that style of gearbox. The result was the robot performed its best during the speed test. This is a surprising finding, since the gear ratio for speed robots consists of a large gear to a small gear, and the one used was the opposite. These results may have come from a faulty robot chassis structure that did not support better torque and might have altered the strength it was able to apply. In the future, I could test out various gear structures that may benefit other gear ratios and I could extend the horizons of my experiment to include a newer, more durable design that may be suitable for all types of gear ratios. I could also develop my array of tests that I performed for the experiment and could increase the number of trials so I could collect more reliable results.

## **The Effect of Tuned Mass Dampers on Buildings Affected by Vortex Shedding**

*Raphael Sanchez, Thomas Jefferson Middle School*

The purpose of this study was to test how much the building sway from vortex shedding was reduced when a pendulum Tuned Mass Damper (TMD) was being used. The independent variable was the amount of damping. The experimental group was the building with a pendulum TMD. The control group was the building without the pendulum TMD. The dependent variable was the building sway, as measured by an accelerometer. The constants were the building, the accelerometer, and the pendulum. The hypothesis was: The trials with the building's TMD unlocked will oscillate less than the trials that will have the building's TMD locked. A model building with a TMD that was set to the natural frequency of the building was treated with different wind speeds. Along with changing the wind speed, the TMD was locked and unlocked (active) to test how effective a TMD would be against vortex shedding. Results showed that the TMD was most effective at reducing building sway at moderate speeds; however, the TMD was not very effective when treated with low and extremely high wind speeds. Thus, the results supported the hypothesis in technicality. In conclusion, the study suggested that TMDs could make a difference when a building oscillates as a result of vortex shedding, but TMDs only make a significant impact on building sway at moderate wind speeds.

## **The Effect of Angled/Curved Wind Turbine Blades on Output**

*Yash Saxena, George H. Moody Middle School*

Over the years, wind turbines have been designed and redesigned to increase energy production. Through the successive generations of wind turbines, every aspect needed to be improved on in some way, and hence, turbine design was created. The purpose of this experiment is to compare the current wind turbine's energy production to a few other ones, such as swastika, arc, adjustable blade designs. After creating the four model wind turbines, they were held in front of a fan for 10 Seconds and the number of rotations were recorded and reviewed. This process was repeated 20 times for each turbine type. The average number of rotations was 23.05 for the swastika blades, 25.35 for the arc blades and adjustable blades, and 20.5 for the swastika blades. The data did not support the hypothesis that stated if a wind turbine has adjustable blades, then they would produce more energy compared to other blades because the arc and adjustable blades had the same mean. Based on the research, every turbine rotated more than the standard blades, but the arc and adjustable blades rotated the most out of all of the turbines. However, before the results can be accepted, it must be tested at a real-life scale with real-life materials, in order to account for physical factors.

## **Invisible Fence: #NotJustForDogs: The Effect of Subdividing an Array of an 802.11ac SOHO Router on the Ability to Localize a Mobile Device**

*Maxwell Sigrest, Louise Benton Middle School*

Invisible Fence: #NotJustForDogs: The Effect of Subdividing an Array of an 802.11ac SOHO Router on the Ability to Localize a Mobile Device determines if triangulation by a SOHO router can be used to determine if a mobile device is inside or outside a Geo Fence. The goal is to prevent undesired mobile devices from connecting to the router if they are outside the Geo Fence. The purpose is to increase the Cybersecurity of small home and office networks by preventing people outside of a defined area from accessing

the wireless network. A Geo Fence provides the network with another defense-in-depth layer, because an adversary that cannot access the Wi-Fi signal, cannot steal network data. For this experiment, I wrote a Matlab model using IEEE 802.11ac WLAN functions and physical properties of a Linksys wrt1900ac router. For localization estimation, I took a novel approach by subdividing the router antenna array into two sub-arrays so triangulation methods could be applied to Direction of Arrival (DoA) estimates computed using the MUSIC (MUltiple Signal Classification) algorithm. I tested ten mobile device locations consisting of five devices inside and five devices outside the Geo Fence. The model correctly estimated the location for four devices, incorrectly estimated the location for two devices, and could not determine the location for the remaining four devices. Average DoA estimation errors of 2.26% were caused by rounding in the MUSIC algorithm, which translated to large localization errors for devices that were farthest from the router. The two devices on the Y-axis were not detected because the DoA's were estimated parallel. The two devices on the X-axis were estimated at infinity because the DoA's were collinear

### **The Effect of the Age of the Cell Phone on the Electromagnetic Radiation**

*Aquib Syed, George H. Moody Middle School*

Electromagnetic radiation is progressively transmuting into the basis of global deaths and medical conditions. The age of the phone can be one of the rudiments leading to superfluous radiation. The purpose of this experiment is to avert deaths and medical conditions instigated by radiation. I am also interested in the focus of radiation, so that is another reason why I am doing this experiment. My hypothesis is that if the age of the cell phone decreases, then the amount of radiation will increase. The procedure is as follows: First, the experimenter took a Samsung Galaxy S5 and put it on a flat surface. He made sure there were no other electronic devices near him. Then, he took an HF-B3G Triple Axis HF RF Power Meter Analyzer and Detector and put it under the Samsung Galaxy S5. Thirdly, he clicked the blue button and started a stopwatch at the same time. He timed 30 seconds. During these 30 seconds, he kept note of the largest number he saw. After these 30 seconds, he clicked the blue button to turn off the detector. He also reset the stopwatch. He repeated these steps 10 times for each of the phones. After this experiment, I observed that the S5 radiation was 4.59 V/M, the S6 radiation was 3.78 V/M, the S7 radiation was 3.22 V/M, and the S8 radiation was 2.59 V/M. I have found out that if the age of the cell phone decreases, then the amount of electromagnetic radiation will also decrease. People should now start getting newer phones, instead of keeping an old phone, as a newer phone is better for your health and has better technology. Phone companies are always making more phones, and more people are buying them. The Stefan-Boltzmann Law states that the total amount of radiation energy per unit area discharged by an object is proportionate to the 4th power of the temperature. So, to reduce the radiation, phone companies are trying to reduce the temperature of their phones, as temperature affects radiation.

### **The Effect of the Angle of the Buckets on a Pelton Wheel on the Amount of Energy Produced**

*Pranithi Thoota, George H. Moody Middle School*

Hydroelectricity, providing 6.14% of the world's electricity, is a phenomenal source of energy. By using the kinetic energy produced by moving water, generators can convert motive power into an electric current. One type of water turbine is a Pelton wheel. A Pelton wheel has buckets along the outer rim, causing the weight of water in each bucket to turn the turbine. By changing the angle of which each bucket is placed at, the speed that the turbine spins at can be altered. If a turbine moves faster, more electricity can be produced in a shorter period of time. Research regarding this should be conducted because it can cause revolutions in energy production. If one succeeds in speeding up a water turbine, then more energy can be produced, lessening the need for fossil fuels. In this experiment, it is hypothesized that if the angle of the bucket on a Pelton wheel was changed, then making the angle smaller would cause the turbine to generate more electricity. To conduct this experiment, three models of a Pelton wheel was built. One had buckets with 45 degrees angles, one had 90 degrees angles, and the final had 145 degrees angles. After being built, they were tested and hooked up to a digital multimeter to determine which one produced the most mVs. The results showed that buckets at 135 degrees angles were the most efficient, then 45 degrees, and the least efficient were 90 degrees angles. To conclude, this differs from the hypothesis because research and previous experiments used water under high pressure, spurting horizontally against the turbine, whereas the experiment conducted relied on gravity for kinetic energy. If this experiment were to be conducted once more, pressurized water should be used for more accurate results.

### **The Effect of Wingtips on the Fuel Efficiency of an Airplane**

*Parth Tornekar, George H. Moody Middle School*

Previous studies have shown that wingtip devices and winglets help the fuel consumption of the plane by as much as 20%. However, many winglets have been created, with some being more efficient than others. Due to the vast majority of wingtip devices being applied, the experimenter decided to find which wingtip device provide the most drag resistance in steady, controlled flight. The research hypothesis for this experiment was, if a Boeing AT winglet is attached to an airplane, then the airplane will fly for the most amount of time under battery/fuel power. Four levels of IV were tested, being Raked Winglet, AT Winglet, Blended Winglet Design and no winglet. Each of these winglets were flown 10 times in a steady 5m by 25m by 10m loop, for 10% of the battery life. When the results were analyzed, the raked wingtip device reduced drag significantly, and increased the time of the airplane's flight by 2.5 minutes from no winglet at all. The AT Winglet and Blended Winglet Design were both very similar in results. In conclusion, the Raked Wingtip device reduces drag better than the AT, Blended and no winglets, and the research hypothesis was not supported. Therefore, in level, calibrated flight, the Raked Wingtip device will reduce drag and increase the time of an airplane in the air.

### **The Effect of Carbon Filtration on Microplastic Content**

*Ben Tsai, Thomas Jefferson Middle School*

The purpose of this study was to find out if carbon filters can filter microplastics. The independent variable was the carbon filter (either with or without). The control group was unfiltered water. The dependent variable was the amount of microplastics, measured by a Likert scale. The constants were the source of water and the procedure used to extract and measure the microplastics. The hypothesis was: If water is filtered using a carbon



block filter, then it will have fewer microplastics. Circles were cut out of one micrometer mesh and placed at the bottom of a large syringe. 20 mL of Nestle Pure Life were poured through the mesh, and then examined under an ultraviolet light. This procedure was then repeated nine times. Two bottles of Nestle Pure Life were filtered using a carbon filter, and ten 20 mL samples were tested using the same procedure. The results showed that filtering water using a carbon filter removed 50% of the microplastics. These results supported the hypothesis. In conclusion, the study suggests that carbon filters should not be relied upon to completely remove microplastics from water.

### **The Effect of Different Obstacles on Wi-Fi Signal Strength**

*Nivriti Vanga, George H. Moody Middle School*

The purpose of this experiment was to test Wi-Fi signals strength when different obstacles were blocking its way to a device. The objects that were used to test with were plastic, wood, cardboard, paper, fabric, metal(steel), glass, and nothing which was the constant. Wi-Fi is radio waves that are sent to a device to provide internet and power to a device. Wi-Fi has changed the way we live, and Wi-Fi signal strength is measured in decibel-milliwatts(dBm). If obstacles made of cardboard, glass, paper, plastic, wood, fabric, nothing, and metal are used to block Wi-Fi signal and Wi-Fi signal strength is measured, then the metal box covering the router would provide the least amount of Wi-Fi signal strength. Before the experiment had begun first the experimenter had downloaded the “Wi-Fi Signal Strength Meter” app by Neo Frontier Technologies on an android phone which was used in every trial for every object. Then, a plastic box was placed on top of a Wi-Fi router until the router is completely surrounded by the plastic. After this the experimenter stood 6 meters away from the Wi-Fi router with the box over it and used the app to find the strength. This was done ten times to every box and in between each trial the box was lifted off the router and then placed back on. The results of this experiment were the constant coming in first place with -55.5 dBm and second was fabric with -60 dBm as their averages. The mean of -60.7 dBm was the cardboard and it was in third. Fourth place was the paper box with -62.2 dBm, fifth was the plastic box with -66.1 dBm, and sixth was wood with -66.3 dBm as its average. Lastly, glass came in seventh with -68.5 dBm for its mean and -74.1 was the average of the steel box for metal and it came in last place. Overall, the hypothesis for this experiment was correct proving that the density of each object was influencing the Wi-Fi signal strength. This would help people with placing their Wi-Fi router in the best spot so the best results can be received.

### **The Effect of Toss Placement on the Accuracy of a Second Serve in Tennis**

*Viktor Vaniakin, George H. Moody Middle School*

In tennis, the serve is one of the key factors of the game. The first serve is more powerful but has a higher risk of going in the net or out of bounds. The second serve is all about accuracy – it has to go in, or the player instantly loses the point. Many factors impact the accuracy; ball toss can be one of them. The purpose of this experiment was to test the effect of ball toss placement on the accuracy of a second serve. The traditional way of tossing the ball is the 1 o'clock position. To achieve a more effective spin, there might be better ways to place the toss – tossing the ball to the right, further away from the server than usual, and even behind the server. In this research, different ball toss positions were tested with the objective of identifying the most optimal ball toss placement, with the

hypothesis that if the tennis ball toss was placed behind the server, then the second serve would be most accurate. Ball toss system was put in place. The server stood in the same position for each serve. A circle with a 45 cm radius was drawn around the server with marked angles for each level of IV: 30°, 120°, 210°, and 300°. Mechanical ball holding device was set up to hold the ball for each of the 4 levels of IV at the corresponding ball toss placement mark. Researcher performed 100 tennis serves for each level of IV. The distance from the target (DV) was measured for each serve to determine the accuracy. The hypothesis was not supported, as position 1 (control) produced most accurate serves, so it is recommended for players to toss the ball in the traditional 1 o'clock position. A ball holding device that was invented as part of this experiment allowed to easily hold the ball position constant for hundreds of trials and can be an effective training tool for players and coaches.

### **The Effect of Different Reflective Materials on the Voltage Generated by a Non-tracking Solar Concentrator**

*Carson Wang, George H. Moody Middle School*

The use of renewable resources is on a rapid rise and solar power is becoming one of the main contributors. Solar power generated 1.2 gigawatts in 2008 but generates more than 30 gigawatts today (Dept. of Energy, 2018). However, solar power does have many downsides including the price. Solar concentrators come in many different shapes and sizes, but they all serve one purpose; to reflect light beams toward a solar cell. There are still many areas where concentrators can be improved, such as the materials used. In the long term, concentrators will help lower prices of solar energy and motivate people to be part of a greener future. In this experiment, the purpose was to observe the effect of different reflective materials on the voltage generated by a non-tracking solar concentrator system. The levels of the independent variable were no concentrator, aluminum foil, glass mirror, and mylar. A parabolic dish (52x56.5x5 cm), sheets of aluminum foil, mylar, and glass mirror tiles (2.5x2.5 cm) were obtained. An empty outdoor location was found, and the solar cell without a concentrator (control), was put at a 35-degree slope and pointed south. A voltmeter was set to 20 V and tested the voltage generated by the cell every 10 minutes from -30 minutes from solar noon to +30 minutes from solar noon. Once the trials were tested, aluminum foil was applied on the parabolic dish and tested and was done for mylar and glass mirror. The data was then gathered. Averages, ranges, and standard deviation were calculated. A bar and line graph were then made. The data did not support the research hypothesis, as mylar did not generate the highest voltage. Using a glass mirror generated the most voltage, followed by mylar, aluminum foil, and no concentrator.

### **The Effect of Different Voltages in Under Voltage on the Temperature of CPUs**

*Raymond Wen, George H. Moody Middle School*

Computers have been around for decades, but the concept of computer technology is only a newer thought compared to when the first computer was manufactured. In the present, computer tech has skyrocketed with many products improving our daily lives. This fast, growing community has brought our generation one of the biggest technological advancements, and new concepts are being invented every day. One step that we took in technology is the ability to change the movement of energy, it is fascinating how

humans have learned to control such a powerful force. Under voltage is the starving of energy to the CPU, it is used to improve other parts of the computer and decrease the temperature of some components. The purpose of the experiment was to determine the effect of voltage changes in under voltage on the temperatures in CPUs. The hypothesis stated, if different voltages in under voltage gradually decreased, then the temperature of the CPU would decrease. The hypothesis was supported by previous research and ideas that stated that excessive use of the under voltage can cause the battery to reduce electricity to the CPU causing cooler components overtime. Four groups were set up with four different levels in voltage. Each was tested by running an application that would change the computer's voltage output into the CPU. The results indicated that the CPU with the least amount of voltage had the most decrease in temperature with a mean temperature of 81.87 degrees Celsius and the CPU that had the most amount of voltage had the hottest temperature. The data supported the research hypothesis that stated if the voltage in under voltage set at no voltage, -5kVA, -10kVA, and -15kVA, then the temperature in CPUs that had -15kVA would decrease the most.

### **The Effect of Temperature on an Electromagnetic Train**

*Natalie Xie, George H. Moody Middle School*

Electromagnetic trains use battery-powered magnetic repulsion and attraction to travel, making them an energy-saving form of transportation. If maglevs traveled swifter, they could become more popular than subways or trains. This would be eco-friendlier as it would decrease gas waste. The purpose of this experiment was to test how the tunnel temperature affected the speed of an electromagnetic train, with the hypothesis being if the temperature of the tunnel was the lowest, then the train will travel through the tunnel in the least amount of time. A tunnel made by coiling copper wire together was submerged in water for one hour to either 16, 19, 22, 25, or 28 degrees Celsius to change its temperature. After being dried, a train made by attaching four neodymium magnets to either side of an alkaline AAA battery was sent through the tunnel fifteen times. The time it took for the train to pass through the tunnel each time was recorded, and the averages compared. When the tunnel was the control temperature, 22 degrees Celsius, the average amount of time it took the train to pass through was 1.66 seconds, and for the 16, 19, 25, and 28 degrees tunnels, the train took 1.46, 1.54, 1.76, and 1.82 seconds, respectively. The hypothesis was supported. This knowledge could be used to make maglev trains more efficient.

### **The Effect of the Type of Fruit Battery on the Voltage Produced**

*Margaret Yacobucci, Swanson Middle School*

The purpose of the experiment was to find the effect of different types of fruit batteries on voltage. In this experiment fruit batteries (pieces of fruit with an electric current running through them between a copper and zinc electrode) were tested to determine their voltage output. The independent variables were 9-Volt batteries, and lemon, orange, apple and lime fruit batteries. It was hypothesized that the apple fruit battery would have the highest voltage, because the expected pH for the apple was the highest. A voltmeter was used to determine the voltage. A 9-Volt battery was tested as a control. The control had the highest voltage, at 9.53 V. The apple battery had the highest average voltage of the fruit batteries, at 0.928 V. The lemon, orange, and lime batteries averaged 0.88 V, 0.873 V,

and 0.863 V, respectively. While the apple fruit battery did not have a higher voltage than the control, it did have a higher voltage than the other fruit batteries, thus confirming the hypothesis.

## **Environmental Science A**

### **Assessment of Campsite Sustainability along the Pacific Crest Trail Corridor in Desolation Wilderness, California**

*Haley Freeborn, Blacksburg High School*

Within the last 30 years, National Parks, Wildernesses, and other protected natural areas have seen a significant increase in visitation (Cole, 1996). This has led to a consequent need for agencies managing those areas to consider the related negative environmental impacts. Sustainable infrastructure such as trails and campsites have thus become a major element in the response to increased visitation. Sustainability was defined in this study by the ability of a campsite to under high-use conditions, maintain low negative impacts on the surrounding environment. Negative environmental impacts included vegetation loss and exposure of soil. For campsites, sustainability can be best indicated by the assessment of the campsites ability to expand and to proliferate. Using previously established campsite sustainability indicators (Marion, Arredondo, Wimpey, & Meadema, 2018), campsites in various campgrounds in Desolation Wilderness, California, were assessed for sustainability. It was found that campsites in Desolation Wilderness are generally naturally sustainable due to the rugose rocky-substrate landscape which the wilderness derives its name from.

### **The Efficacy of Various Polymer Plastics on the Removal of Estrogen from Water**

*Holly Acker, Roanoke Valley Governor's School for Science & Technology*

The purpose of this project was to determine if different polymer plastics would reduce estrogen concentrations by a significant amount. The materials tested were polycarbonate, nylon, and polyester fleece. These were chosen because they have been shown to adsorb estrogen and contribute to plastic pollution. It was hypothesized that at least one of the materials would significantly reduce the estrogen concentration. A 533 ppt estrogen solution was passed through four filters: one for each material and a control. The final estrogen concentrations were measured using a competitive assay that involved the binding of the estrogen samples to an antibody. If the estrogen concentration was high, the samples would bind to all of the antibodies and produce a lower absorbance value. The assay was performed under a time constraint which allowed for experimental error that likely altered the data. The absorbance values collected were highly varied and a standard curve to determine estrogen concentration was unreliable. The mean absorbance value for each material was analyzed using a one-way ANOVA which concluded that the control had a significantly higher mean absorbance value than the other materials. This result is the opposite of the original hypothesis as it implies that the control was the most effective at reducing estrogen concentrations.

### **The Effect of Various Environmentally Friendly Algae Deterrents on the Control of Phytoplankton Growth on Plastic**

*Ankita Adhvaryu, Mills E. Godwin High School*

The experiment endeavored to determine the effect that various algae deterrents have on the growth of algae on a plastic substrate. Every year, thousands of birds suffer from the consumption of plastic. This is due to algal growths on the plastic releasing the chemical dimethyl sulfide, which attracts seabirds, causing them to eat the algae and with it the plastic. The current study involves growing algae on plastic substrate in a petri dish containing synthetic sea water and subjecting the algae colony to either hydrogen peroxide, sodium bromide solution, or barley extract. After a period of time, the percent change in amount of algae diminished was calculated for each petri dish. The control was the group of petri dishes that had no additional deterrent added to it, as it provided a representation of what would happen to the algal growth on plastic without any interference. The results revealed that the hydrogen peroxide was most effective in decreasing algal growth on the plastic, supporting the hypothesis. T-tests were performed on the data and it was found that the data was overall significant, except for sodium bromide solution vs. no deterrent added. The experiment concluded that hydrogen peroxide was the most effective algae deterrent, followed by barley straw extract, and sodium bromide solution. These results are most likely due to the hydrogen peroxide producing more dissolved oxygen which created an undesirable habitat for the algae to grow in. In the future, the premise of this investigation can be extended and applied to help decrease the negative consequences of plastic pollution on birds and marine animals. As well, further studies can be done to determine how the effects of various deterrents vary amongst different species of algae.

### **The Effect of Day-night Cycles of Plants on Carbon Sequestration**

*Eugene Akoto, Mills E. Godwin High School*

Artificial carbon sequestration or direct air capture presents a method of extracting CO<sub>2</sub> from the air, storing it in proposed facilities where they will be converted to a safer form of energy or fuel. The process occurs when liquid adsorbents react with CO<sub>2</sub> in the air. One of the factors that can influence the effectiveness of the CO<sub>2</sub> capture process is the type of plant life surrounding the adsorbent and times when they perform photosynthesis and respiration depending on their day-night cycle. An experiment was conducted to determine the effectiveness of DAC with a liquid adsorbent at different times of day. It was hypothesized that if DAC is performed at 6pm by Ca(OH)<sub>2</sub> in the presence of a group of plants, then it will capture the most CO<sub>2</sub>. Cups of 250 milliliters of Ca(OH)<sub>2</sub> were exposed to air next to a plot of rose plants and the change in pH was recorded at 6am, 12pm, and 6pm. The data was used to calculate the amount of CO<sub>2</sub> that was reacted with. The data was found to be statistically significant with a t-test comparing all the days, and the results showed that carbon sequestration was most effective at 6pm than other times of the day and due to the incapability of photosynthesis at night which would otherwise decrease CO<sub>2</sub> in the air. The data suggests the benefit of running DAC facilities at night to increase CO<sub>2</sub> capture and can be applied to planning future construction.

### **The Effect of Material Type on Speed of Degradability**

*Hannah Ahmed, Mills E. Godwin High School*

The purpose of this experiment was to find the effect of different types of material on their speed of degradability. The prevalence of plastic waste is a growing concern as it is greatly polluting the earth and harming its inhabitants, therefore this experiment aimed to

test for safer, degradable materials to solve this problem. In this experiment non-biodegradable, biodegradable, and plant-based materials were tested. Items were buried for six weeks and their masses were measured afterwards. There was no control; the items were being compared to one another rather than a separate category as there is no one material items are generally made of which the degradation rate is standard. It was hypothesized that the plant-based items would degrade faster than other materials. The results revealed that plant-based items degraded faster than non-biodegradable and biodegradable items; the plant-based average degradation amount was 1.15 grams. A t-test was done on the data and it revealed that the data was significant for biodegradable vs. plant based but not significant for non-biodegradable vs. plant based and non-biodegradable vs biodegradable. The results supported the research hypothesis. It is assumed that the results are due to the fact that polymers are not degradable while cellulose and natural fiber bases as well as polyhydroxyalkanoates aid in decomposition of material. This research could lead to further studies that investigate the fastest degrading material in various conditions and polymer bonding that may affect degradability.

### **The Effect of Different Types of Potatoes on the Melting Point of Bioplastic**

*Ansah Akhtar, Washington-Lee High School*

This project was conducted to identify the melting points of bioplastic made from different species of potatoes. The bioplastic was tested with an electronic thermometer to ensure the temperature recorded was valid. Certain benefits in conducting this experiment were to create the best type of bioplastic that can sustain the needs of the world's growing population. By figuring out the melting point of different types of bioplastic, plastic manufacturing companies can later implement these types of renewable sources into plastic and create a plastic that was both usable as well as beneficial to the environment. The hypothesis was that if the sweet potato was used in the creation of bioplastic then the bioplastic would have the lowest melting point. The hypothesis was supported. The types of potatoes used in the project were russet, sweet, and red potatoes. Starch was, first, extracted from the potatoes then used to create bioplastic. Later it was tested to measure the melting point of the bioplastic. Each type of bioplastic was tested 10 times each. The average and standard deviation were calculated for each potato bioplastic using the data. This was done to determine if the variables were significantly different. An ANOVA test and T-Test was conducted with the data collected. An unavoidable problem present in the experiment was how the bioplastics were exposed to oxygen and other variables that could have affected the temperature at which it melts. This problem was unavoidable because if the bioplastic mixture was kept in an airtight container it could have caused molding or even the delay of the bioplastic forming in time.

### **The Effect of Carbonated Drinks on Heart Rate**

*Mahin Atturu, Mills E. Godwin High School*

The purpose of this experiment is to determine if additives to carbonated drinks have an effect on the heart rate of *Daphnia magna*. Recently, carbonated drink industries have been steadily increasing in popularity. In order to test the effects of the carbonated drinks, a sample of 125 *Daphnia magna* were used. The *Daphnia magna* were treated with a drop of either Coca Cola, Mountain Dew, Fanta Orange, Sparkling Juice, or Sparkling

Water. The control that was used in the experiment was the Sparkling Water due to the fact that there are no extra additives. It was hypothesized that *Daphnia magna* exposed to Mountain Dew would have the greatest change in heart rate. The results revealed that *Daphnia magna* exposed to Sparkling Juice had a greater change in heart rate than the *Daphnia magna* exposed to Mountain Dew. A t-test was performed on the data and it was revealed that the data was significant for the Control versus Sparkling Juice, the Control versus Mountain Dew, the Control versus Fanta, Sparkling Juice versus Coke, Sparkling Juice versus Mountain Dew, and Sparkling Juice versus Fanta, but was not significant for the Coke versus the control, Coke versus Mountain Dew, Coke versus Fanta, and Mountain Dew versus Fanta. The results did not support the research hypothesis. It is believed that the results are due to the way the manufacturers create the product. Different sodas use different compositions, creating new tastes and products. This research could lead to further studies that investigate other varieties of liquids instead of just carbonated drinks.

### **Analysis of Sediment Health in a Contaminated Section of the Lower James River**

*Kenneth Beam, Chesapeake Bay Governor's School for Marine & Environmental Science*

Persistent Organic Pollutants are environmentally toxic chemicals that have a long lifespan in the environment. Kepone was manufactured from 1966 to 1975 at the Allied Chemical Plant in Hopewell, Virginia. In 1974, employees began illegally dumping Kepone down drains emptying into the James River. The purpose of this study is to determine if the deeper sediments in the spill zone along the James River are harmful to organisms. Winogradsky columns were used to determine the bacterial growth of sample sites relative to the depth of the core and a control. A survivorship test was used to test the toxicity of sediment on common mud crabs, genus *Panopeus*. Across the experiments, there was an overall growth and survivorship. In Winogradsky columns, no statistical difference was found across all sites. Mud Crab survival shows a trend that the less organic material and sandier the sediment, the higher the survival rate, linear regression analysis  $R^2=0.7821$ . It is critical to continue to investigate Kepone in the sediments of the James River because it may still be active and a potential threat. This study provides hope, and further studies on Kepone contamination can look into the future for the health of the James River.

### **The Case for Permeable Property in Arlington**

*William Bernhardt and Haylee Feist, Yorktown High School*

### **The Effect of Differing Levels of Streamflow on the Prevalence of *Ephemeroptera*, *Plecoptera* and *Trichoptera* and the Biodiversity of an Aquatic Environment**

*Chelsea Brennan and Emma Levon, Clover Hill High School*

### **The Effect of Land Use on Dissolved Oxygen and Nitrates**

*Emily Brown, Chesapeake Bay Governor's School for Marine & Environmental Science*  
The use of land for development and agricultural purposes has been linked with the deterioration of the water's quality it surrounds. Many studies have been conducted to observe the impact of various land uses on water quality. One study found that differences

in land use and management practices are considered the key influencing factors of the change in runoff and water quality. Additional knowledge on this subject can aid in deciding how to best manage our resources and land in order to keep surrounding waters healthy. This study compared how a stream's dissolved oxygen and nitrate levels change as the stream goes from its headwaters to the mouth with various land uses. It was hypothesized that dissolved oxygen (O) may decrease while nitrates (N) would increase as water flowed down the stream from the headwaters to the mouth. Data was collected at 5 sites and tested using dissolved oxygen and nitrate kits. The dissolved oxygen levels had a decreasing trend with the exception of site 2 (woodland) and the single factor Anova test resulted in a p-value of 0.28. The levels of nitrate could be contributed to the testing being conducted in the fall instead of spring when most agricultural is occurring. The nitrate levels had an increasing trend with the exception of site 5 (mouth) and the single factor Anova test resulted in a p-value of 0.16. This could suggest that nitrates continually built up as the water flowed from site 1 to 5. Additionally, the lower nitrate level at site 5 (mouth), could be contributed to the diluting effect of the water meeting with the river. The results can aid in making decisions about the best approach to protect waterways from potentially harmful land use practices. The healthier waterways are, the more abundant and diverse its populations of organisms can be. Protecting small creeks will help keep bigger bodies of water like rivers and even oceans cleaner, healthier, and safer for future generations.

### **Carbon Sequestration in the Urban Forest of the James River Park System**

*Beverly Buchanan and Milan Marsh, Open High School*

Global warming has resulted in the rise of temperatures between 0.3 and 0.6 °C since the late 1800s and continues to increase at a rate of 0.1 °C per decade in our oceans and 0.05 °C per decade in the air (Shah 2019). Carbon sequestration by trees is the process in which carbon is utilized during photosynthesis and is stored as the tree's biomass, reducing atmospheric carbon, the most common greenhouse gas. Our study is a collaboration with a citizen science research project called Science in the Park that established plots of trees at three different sites (Upland plot, Lowland plot, and Riparian Plot) in the James River Park System. The question we were trying to answer was whether location or species composition impacted carbon sequestration rates. To begin to investigate our question we established our own subplot in the Upland location on Belle Isle (BI) consisting of 20 trees, which we named the "Upland Island", and measured baseline data in 2019 for comparison over time. We used our collected data and compared that to existing data in the Upland plot on the Buttermilk Trail (BT) for 2018 and found that the carbon mass went down to which we realized was due to the fact that we sampled species that collected less carbon than what were collected in 2018. We also looked at whether hardwood tree species or softwood tree species assimilated more total carbon mass overtime and found that softwoods sequester more carbon, but that the rate of change between hardwoods and softwoods were nearly the same. We used line graphs and slope calculations to determine how much carbon were the most abundant tree species in each location sequestering. The majority of tree species in each location experienced an increase in the total carbon mass.

### **Testing Oil Absorption of a Cellulose Barrier on Cardboard**



*Isabella Burgoyne, Southwest Virginia Governor's School*

Although cardboard by itself is recyclable, many pizza boxes cannot be recycled because grease seeps into the box and contaminates the cardboard. Since grease cannot be separated from the box during the recycling process, whole batches of recyclables are contaminated. The goal of this experiment was to create a biodegradable cellulose barrier created from corn husks and cassava that absorbs oil to prevent the contamination of cardboard pizza boxes, allowing them to be recycled. To test oil absorption of the barrier, hot oil was applied to individual test samples and assembled using a cassava-based adhesive. Excess oil and the mass of the samples were measured before and after testing. A prototype of the barrier was then created to test a real pizza delivery box. Samples from testing and the prototype were examined using an optical microscope. Statistical analysis using the ANOVA test, Tukey HSD test, and qualitative analysis provided a p-value of 0.0008 from mean values 11.92 mL, 10.28 mL, 8.60 mL, 8.28 mL, and 6.64 mL, and a p-value of 0.0029 from mean values 4.36 g, 1.98 g, 3.84 g, 3.68 g, and 4.77 g, which supports that there is a statistical difference between test groups and between the prototype and control. Results showed a significant increase in the amount of oil that was being absorbed by the corn husk barriers and a reduction in the amount of oil remaining after testing.

### **The Correlation between the Populations of *Crassostrea virginica* and *Ulva lactuca* on the Oyster Castles at Greenbackville, VA**

*Jessica Byers, Washington-Lee High School*

The Eastern oyster, *Crassostrea virginica*, plays an essential role in bay ecosystems due to its ability to filter up to 50 gallons of water a day, improving the water quality for other organisms. In areas where previous oyster shucking business is prolific, such as Greenbackville, current oyster populations are dwindling. Even with the installation of oyster castles, the Greenbackville population has yet to see a resurgence. There has been significant growth in several algae species, namely *Ulva lactuca*, better known as sea lettuce. Past research has indicated that sea lettuce can negatively influence oyster growth. Based on this research, there will be a negative correlation between sea lettuce and oyster populations. A visualization technique was used to estimate the percent coverage of general algae, sea lettuce, oysters, and empty space. The oyster category was then broken-down into the percentage of dead oysters and percentage of live oysters. The analysis of this data indicated a positive correlation between the sea lettuce and oyster populations. This was backed by a p-value that was less than 0.05, making the results significant. On the other hand, there was a negative correlation between the general algae and oyster populations. This was also backed by a significant p-value. The pie-charts reveal that there was not a high population of sea lettuce, which might be a factor in the results. It is possible there is another extraneous factor that is causing these results, but more research would be needed.

### **The Survival and Growth of *Sinapis alba* when grown under UV-B radiation**

*Kennedy Campbell, Central Virginia Governor's School for Science & Technology*

The purpose of this study was to determine if increased levels of UV-B radiation had an effect on *Sinapis alba* height and leaf width. Three radiation groups were analyzed; group one (control) had only general fluorescent bulbs, group two had a general fluorescent

bulb and a UV-B100 relative spectral power (RSP) bulb, and group three had a general fluorescent bulb and a UV-B150 RSP bulb. Three randomly selected *Sinapis alba* seeds were placed into a 3 in<sup>2</sup> pot, and six of these pots were placed in each of the three radiation groups. Every week, for three weeks, each plant's height and leaf width were measured in cm. Using the weekly averages of each group's plant height and leaf width, multiple one-way ANOVA tests were applied to determine the p-values each week. For plant height, the p-values were 1.6E-04 for week one, 3.028E-06 for week two, and 6.006E-06 for week three, and for leaf width, 5.05E-09 for week one, 9.417E-06 for week two, and 4.564E-13 for week three. When compared to an alpha of .05, a statistical significance was suggested. A post-hoc Tukey Test was used to discover the control group was statistically higher than the other groups in every test. This supported the research hypothesis that if *Sinapis alba* are grown under varying levels of UV-B, then the control group will have the largest heights and leaf widths. In conclusion, UV-B levels significantly affect the growth of *Sinapis alba*.

### **The Effect of Proximity to Airports on Water Lead Levels**

*Sydney Coffman, Mills E. Godwin High School*

The purpose of this experiment was to determine if schools nearer to airports have higher lead levels in puddles. Lead is a naturally occurring element found in airplane fuel. Rain will turn this fuel into runoff, which can reach schools. Lead can accumulate in playground puddles posing danger to children. Elementary schools 2.25 km, 1.41 km, 3.42 km, and 32.5 km from an airport were selected based on airport proximity. The school 32.5 km, the control, was the farthest from the airport. Puddle water from each school was collected in four containers. Using a test kit, lead levels were determined at each school. The data was organized in two tables and a bar graph. A research hypothesis predicted that schools nearer to airports would have higher lead levels. The mean lead levels of the school 1.41 km away (212), 2.25 km away (148), 3.42 km (110), and 32.5 km (13) were calculated. The school 1.41 km away had the highest lead levels, while the school 32.5 km away had the lowest, supporting the hypothesis. The calculated standard deviations were close to zero, showing precise data. T-tests conducted had values greater than the table value, 2.01, at a probability of 0.05, indicating significant data. According to research, lead remains in soil, as it binds to the organic compounds within. Therefore, schools nearer to airports have higher lead levels. Future experiments could be conducted to determine how precipitation impacts lead levels. In addition, tests could include different elements based on location.

### **The Effect of Air Circulation on Short-term Radon Levels**

*Alexander Coffman, Mills E. Godwin High School*

Radon is a gas which causes over 20,000 deaths yearly due to increased radiation. The purpose of this study was to determine the effect of air circulation and dehumidification on radon levels. Based upon previous research, it was believed that if both a dehumidifier and an HVAC system were used simultaneously, then that testing environment would result in the lowest radon levels. This research hypothesis was later supported due to a successful exchange between indoor and outdoor air. The levels of independent variable included using no air treatment (control), an HVAC fan, a dehumidifier, and both types of air treatment together. All levels of independent variable were applied individually, and

the first radon reading for each level of independent variable was recorded after 48 hours. Further readings were recorded every 24 hours, until 25 readings were recorded. Then, all steps were repeated once for each level of independent variable, and all testing was repeated a second time in reverse order. The results indicated that both a dehumidifier and HVAC running simultaneously resulted in a lower radon level, with a mean radon level of 1.424 pCi/L, while other levels of independent variable had mean radon levels of 1.65 pCi/L (dehumidifier), 1.468 pCi/L (HVAC), and 1.816 pCi/L (control). The standard deviation for testing was between 0.455 and 0.182, which indicated precise results. The dehumidifier trials had an insignificant t-test at a probability value of 0.001, while all other data had significant t-tests. Future considerations include outdoor relative humidity and wind speed.

### **Lead Toxicity and its Risk to Wildlife and Humans through Fragmentation**

*Christiana Cole, Andrea Fox, Noah McIntire and Hannah Miller, Harrisonburg High School*

### **Changes in the Fouling Community in Oyster Sanctuary Reefs**

*Madison Dent, Chesapeake Bay Governor's School for Marine & Environmental Science*

In the Chesapeake Bay, many marine organisms are dependent on the main benthic habitat-oyster reefs. Epibenthic macrofauna, also known as fouling organisms, support the benthic food chain in much of the Chesapeake Bay and add to the local biodiversity where they live on the oyster reef substrate. Macrofauna are strongly dependent on oyster reef as benthic habitat and biodiversity levels fluctuate due to ecological succession and competition. Climate change is further affecting the conditions for life in the estuary by increasing the water temperature and affecting precipitation which is altering the overall water quality that the macrofauna depend on. Invasive species also directly affect the macrofaunal fouling community in the Chesapeake Bay. The purpose of this research project is to examine seasonal changes in the macro-benthic fouling community on a restored oyster reef substrate. The results were analyzed based on date according to the abundance and diversity of macrofaunal organisms on each oyster individually and compared to salinity and precipitation levels. Epibenthic macrofaunal diversity was analyzed from May- November and there was a 78.55% change in diversity on the oysters over the period and the abundance levels of macrofaunal organisms decreased with a -2260% change. The findings showed decreasing salinity levels due to increased precipitation affected by climate change lowers biodiversity levels and life in the water. Based on the results of this study, some precautions should be taken globally to slow the loss of macrofaunal organisms and increase oyster reef restoration projects to build more habitat to reduce disturbance of these organisms.

### **The Effect of Different Seagrass Species on Carbon Sequestration**

*Pavan Desai, Mills E. Godwin High School*

### **The Effect of Propeller Shape on the Amount of Energy it Produces**

*Natalie Ellis and Keira Taylor, Washington-Lee High School*

## **Environmental Science B**

### **The Effects of Propolis Based Pesticides for Use in Agricultural Settings**

*Melany Fuentes, Southwest Virginia Governor's School*

The rise of consumer awareness of the harmful effects of pesticides, such as nicotinoids, pose on health has spurred the need for a safer and organic alternative. Propolis, a natural compound produced by bees, has been shown to have antibacterial and antifungal properties. Propolis has even been shown to deter and kill pests commonly found in beehives and has been used in ancient medicine as seen in Aristotle's works. The objective of the study performed was to discover if a propolis based pesticide could deter pests and be considered as a viable alternative to the pesticides currently on the market. The study focused on the behavior of *Pogonomyrmex barbatus*, commonly known as red harvester ants. To determine if the propolis based pesticide would be effective, ant behaviors were monitored when exposed to a sugar-based food that had been submerged in the propolis solution. There were four test groups with one being a control group. The results of the observation were tested for significance using a chi square test which ultimately resulted with insignificant results. After 30 seconds of being exposed to the control group and different concentration groups, a p-value of 0.1342 and after five minutes of exposure a p-value of 0.0778 resulted. Both p-values indicated insignificant data. This study suggests that propolis does not have the capabilities to deter pests outside of a beehive environment and ultimately does not have the characteristics desired in a pesticide.

### **The Effect of Compost Contents on the Approximate Chemical Concentrations in the Resulting Soil**

*Caroline Gage, Washington-Lee High School*

The project was created as a result of the growing use of harmful chemical fertilizers in soil to provide Nitrogen (N), Phosphorus (P), and Potassium (K) and their effects on the environment and humans. A solution to this problem was presented in compost. By using organic materials that already contain the aforementioned chemicals in compost, an alternative to fertilizers could be created. The hypothesis posed this: if different concentrations of green (fruits, vegetables, plants) and brown (mulch, dead leaves, twigs) materials are composted, the compost created with equal amounts of greens and browns will result in the most N-P-K rich soil. The materials were divided into five groups; each group had varying percentages of browns and greens. 100% browns, 75% browns and 25% greens, 50% browns and 50% greens, 75% greens and 25% browns, and finally 100% greens. They were placed in glass jars and left in direct sunlight to compost for four weeks. Twice a week, the materials were mixed with a small amount of water. The concentrations of N-P-K were tested with a LaMotte N-P-K Soil Test Kit in kilograms per hectare. After using the soil test kit, it was found that the concentration of N-P-K increased as the percentage of greens did. In terms of the most chemically rich, the 100% green compost was on top. However, in terms of the optimal levels for plant growth, the best combination was 50% brown and 50% green compost.

### **The Effect of Turbidity on Oxygen Production of Aquatic Plants**

*Ian Garland, Central Virginia Governor's School for Science & Technology*

The purpose of this study was to determine if the presence of turbidity in an aquatic ecosystem had an effect on the dissolved oxygen output of plants. The hypothesis was that if one increases the amount of turbidity present in a waterway, then the dissolved oxygen level will decrease. Four different tanks had the following turbidity levels: tank one at zero Nephelometric Turbidity Units (NTU), tank two at 22.1 NTU, tank three at 27.9 NTU, and tank four at 41.2 NTU. Once plants were added to the tanks, temperature, dissolved oxygen, turbidity, and pH levels were recorded every Monday, Wednesday, and Friday over the course of three weeks. The dissolved oxygen averages were as follows: tank one, 7.46 mg/L; tank two, 8.36 mg/L; tank three, 8.41 mg/L; tank four, 8.48 mg/L. A one-way ANOVA was then performed to determine if there was a significant difference between the dissolved oxygen groups, which yielded a p-value of 6.15E-6. With an alpha value of .05, significance was suggested between the groups, so a Tukey Test was performed to determine which groups contained significance. A D min value of .488 suggested significance only between the control group and all the other tanks. The research hypothesis was not supported since the analysis suggested that turbidity, at any level, must be present within a tank for there to be dissolved oxygen.

### **The Effect of Different Pollutants on the Turbidity of Pond Water**

*Aadhira Gopalan, Mills E. Godwin High School*

This project was conducted in order to determine whether or not some of the most commonly used household pollutants cause a significant change in the turbidity of pond water. It was hypothesized that if these pollutants were tested, then the fertilizer would cause the greatest change in the turbidity of the pond water. Discovering which one of these pollutants caused the most significant change would allow for the advising household users of these products to not only cut down on them but to also use them in a more environmentally conscious manner. The pollutants and pond water were added into the sample cells such that there was a one to nine ratio of the pollutant to the pond water, and the cell was placed in the sensor in order to view the turbidity reading. The control in this experiment was the group of pond water tested without any added pollutant. The results showed that the fertilizer did have the highest mean difference from the control group when compared to the other pollutants. T-tests were performed on the subsequent data, and all of them showed that each pollutant made a significant difference. This implied that the data was caused by the independent variable. Due to this significance, it is believed that the pollutants did cause a significant difference in turbidity, and that the results were not due to chance. The research hypothesis was also supported by the data showing that the fertilizer test group had the highest mean difference from the control group.

### **The Effect of Plastic Concentration on the Rate of Water Evaporation**

*MaryGrace Gozzi, Clover Hill High School*

This experiment was designed to discover the effect of plastic concentration on the rate of water evaporation. The experimental hypothesis stated that if 3 kg of plastic waste were present in a 40L tank of water, then the evaporation rate would be the slowest. To test this hypothesis, 10 cm of water were added into the tank, which had been marked with 20 millimeters measurement lines. Zero kg, 1 kg, 2 kg, and then 3 kg of plastic waste were added separately into the tank for each group of trials. A heat lamp was positioned above the tank and was used as an energy source and evaporation catalyst. Once the

plastic was present in the tank, and the heat lamp was turned on, a stopwatch was started. Once 1 cm of water had evaporated out of the tank, the stopwatch was stopped, and the time (in minutes) was recorded in a data table. If the recorded time was longer than that of the control, then the plastic had successfully decreased the rate of evaporation. The average recorded times for each group, 115.8 minutes for 0 kg of plastic, 192.3 minutes for 1 kg of plastic, 242.8 minutes for 2 kg of plastic, and 312.3 minutes for 3 kg of plastic, supported the original experimental hypothesis. The experimental data was also analyzed using an ANOVA test. In this test, the F-critical value was 2.87 and the F-calculated value was 273.81, proving the data as statistically significant. These results revealed that plastic acts as a block to radiation, as it reflects the light before it can reach the surface of the liquid water and turn it into vapor.

### **Rising Tides: Assessing the Potential Marsh Loss to Higher Sea Levels**

*Tristan Gross, Chesapeake Bay Governor's School for Marine & Environmental Science*

This study observed the rate of sediment build-up in several marshes along the Rappahannock River. The increasing rate of sea level rise threatens to flood tidal wetlands that cannot capture sediment and biomass quickly enough. Two factors were manipulated during data collection. Observation occurred at three different tidal marshes along the Rappahannock River and sediment accumulation was observed in incremental distances from the shoreline. It was hypothesized that sediment accumulation would be the greatest near the water for each test site and also that sediment accumulation would be greater at location's further upriver. In order to test this, three sediment pins were placed at each test location for a period of six months, with researchers returning every two weeks to record changes in their heights. At the end of the study it was determined that in all three marshes sediment accumulation is near zero twelve meters from the shoreline. It was also determined that the rate of sediment accretion was greatest downriver. The results of this study support the idea that all tidal marshes along the Rappahannock River are vulnerable to extreme topographic change as the sea level rises. The extremely low rate of sediment accretion deeper into each marsh suggests no marsh is building backward fast enough to adapt to sea level rise. Preventative measures to increase the flow of organic material and sediment flow near tidal wetlands are necessary to conserve Virginia's marsh ecosystems.

### **The Effect of Grocery Bag Material on the Change in Mass of Material after Being Composted**

*Elyse Hartmann, Washington-Lee High School*

The purpose of this experiment was to study the effect of grocery bag materials on their rate of decomposition. Five types of grocery bags were tested in a 20 L compost bin. The different materials were paper, polyethylene plastic, Glad compostable plastic, If You Care compostable plastic, and biodegradable plastic. The data from this experiment could be used to encourage more people to compost instead of increasing the amount of waste in landfills. The hypothesis was: if the type of grocery bag material is changed, then the paper grocery bag will have the most percentage of mass decomposed because it is made up of cellulose. The hypothesis was supported because the paper decomposed 100% and If You Care compostable plastic decomposed the second most with an average of 6.81%. It was concluded that compostable plastics decomposed more than

polyethylene plastic did because the If You Care compostable plastic had an average 5.79% higher than the polyethylene plastic. It was also concluded that the biodegradable plastic and the polyethylene did not decompose at different rates because the data was not significant. The material most suited for compost is paper, though if it is not composted then it remains in landfills just like any of these other grocery bag materials.

### **The Effect of Organic and Inorganic Fertilizers on the Weight of Earthworms**

*Emily Haueis, Mills E. Godwin High School*

The purpose of this experiment was to determine the effect of different fertilizers on the weight of earthworms. Inorganic and organic fertilizers are both being used in modern agriculture. The effect of these fertilizers on crop production continues to be researched, but it is important to understand the effects on the soil biomass including soil-dwelling organisms such as earthworms. A study was developed where five groups of twenty-five earthworms were each weighed and placed in a different cup of soil, with one type of fertilizer mixed into one group respectively. A control group did not receive any fertilizer. The worms were weighed weekly for four weeks. A hypothesis was formulated that if earthworms are exposed to either organic or inorganic fertilizer, then the earthworms that are exposed to inorganic fertilizers will have the highest decrease in weight. The mean for each group was calculated, with organic bone meal having the highest increase in weight (1.188g) and inorganic urea-based fertilizer having the highest decrease in weight (1.124g). T tests were calculated and all but one set of data was significant, that being the comparison between organic blood meal and inorganic ammonium-nitrate based fertilizer. It is believed that the results are due to the fact that urea-based fertilizers create an inhospitable environment for earthworms, resulting in significant weight loss as well as a high mortality rate. Earthworms are necessary for plant development, and this study should lead to further research on the effects of fertilizers on soil biomass and not just maximum crop yield.

### **The Effect of Sunscreen Brand on *Daphnia magna* survival**

*Caroline Hedrick, Mills E. Godwin High School*

The effect of different brands of sunscreen and their effect on the mortality of *Daphnia magna* after 24 hours was studied to discover if they are as toxic to *Daphnia magna* as they are to coral reefs. One of the main active ingredients in many sunscreens, oxybenzone, causes coral bleaching and could potentially harm other communities. The hypothesis formulated was that sunscreens with higher concentrations of oxybenzone will have the highest toxicity. The experiment was conducted by making solutions of water and each sunscreen and separating each mixture into five 30 mL cups. Then, twenty-five *Daphnia magna* were added to each cup. After 24 hours, the amount of alive *Daphnia* was recorded. The levels were Coppertone, CVS Sport Face, Tropic Sport, and a control. Tropic Sport has no oxybenzone and is advertised as reef safe. The control was plain bottled spring water. The results were that CVS Sport Face had the highest mortality with nine alive and the highest percentage of oxybenzone, Coppertone had 10 alive and 2% less oxybenzone than CVS Sport Face, and Tropic Sport had 18 alive at the end. The control had all 25 alive. The chi-square was significant and equaled 21.2 which was greater than the table value of 7.815. The conclusion of this experiment is that oxybenzone is toxic to *Daphnia magna* which is why the oxybenzone sunscreen caused

the highest mortality. Luckily, oxybenzone can be avoided with other products to prevent damage to aquatic organisms. Further research could use pure chemicals or more concentrations of oxybenzone.

### **The Effect of Varying Concentrations of Oxybenzone on Cell Density in *Chlorella* and *Chlamydomonas***

*Summer Hensley, Central Virginia Governor's School for Science & Technology*

The purpose of this study was to determine whether adding oxybenzone in varying concentrations to the mediums in which microalgae *Chlorella* and *Chlamydomonas* were grown would affect cell density. First, two 500 mL flasks were set up with equal parts spring water and Alga-Gro freshwater medium and an air stone in each flask, and the microalgae were allowed to culture under a 12-hour light cycle for three weeks. Then, three mediums were created with varying concentrations of oxybenzone: 0.001 mg/mL, 0.002 mg/mL, and 0.003 mg/mL. After this preparation, both *Chlorella* and *Chlamydomonas* were dyed with safranin and viewed under a ZEISS Primo Star microscope, and the original density was measured in cells/mL using a hemocytometer. Next, eight 500 mL Erlenmeyer flasks were designated - two for each concentration of oxybenzone, plus two control flasks with the original medium - and the microalgae were transferred into them. Then, the flasks were stored for two weeks, and the density was measured again with the same method. Finally, the microalgae were disposed of, and all equipment used was cleaned and returned to storage. A linear regression test was performed to examine the influence of the oxybenzone on cell density, and the p-values received for *Chlorella* and *Chlamydomonas* were .86 and .82 respectively ( $\alpha=.05$ ). Implementation of a Tukey test suggested significance between groups but was likely caused by outliers in data. Therefore, the hypothesis that as the oxybenzone concentration increased, the cell densities of both microalgae would decrease was rejected.

### **Chemical Versus Photochemical Degradation of Crude Oil**

*Maddison Hughey, Mathematics & Science Academy at Ocean Lakes High School*

This experiment investigates whether natural or chemical degraders of crude oil are more effective. To clean up oil spills, thousands of chemicals are dumped into the ocean. These chemicals hurt the environment more than the oil. Natural degraders of crude oil have unharvested potential to be a more efficient degrader than a chemical one. If natural and chemical degraders are used to oxidize crude oil, then the natural degrader will oxidize the oil the most. This experiment uses sunlight as the natural degrader and hydrogen peroxide as the chemical degrader. Aged Macondo oil was used for each trial. The photodegradation trials were placed in direct sunlight for 120 hours. For the peroxide trials, one mL of hydrogen peroxide was added each day for five days. The samples were then analyzed by the FTICR at Old Dominion University. The results showed photodegradation oxidized the oil the greatest out of the two trial. This supports the hypothesis in which natural degraders are the most profitable when degrading oil. In the future, natural degraders could be harvested to clean oil without harming the environment.



## **Using Waste Biomass-based Electrodes in Electro-coagulation for Lead and Phosphate Removal from Water**

*Janine Icalla, Mills E. Godwin High School*

Heavy metal water pollution and eutrophication continue to be growing concerns for the health of global water systems. Additionally, there continues to be an ongoing crisis involving food waste management, with most food waste destined for landfills and incinerators that release toxic chemicals and gases into the surrounding environment. Current methods of water remediation are extremely costly and unavailable to many third-world countries; therefore, it is crucial to find more economical alternatives. In this research, three waste materials were used for the creation of carbon electrodes, as opposed to typical metal electrodes, for use in electrocoagulation: spent coffee grounds, banana peels, and orange peels. The electrocoagulation process occurred for thirty minutes with each trial in an electrolytic cell that consisted of the waste-based carbon electrodes and a beaker containing a 0.01 M lead phosphate solution, simulating a tertiary wastewater treatment. Spectrophotometric determination was then used to calculate the removal efficiencies of each of the waste-based electrodes. The results revealed that the SCG-based electrodes had a lead and phosphate removal efficiency of 97.1%, which was 2.6% higher compared to the removal efficiency of the BP-based electrodes and 2.1% higher compared to the removal efficiency of the OP-based electrodes. A one-way ANOVA test completed at an alpha level of 0.05 followed by a Tukey's HSD post-hoc analysis revealed the data to be statistically significant. The highly porous structure of the spent coffee grounds in comparison to the banana peels and orange peels is believed to be the primary reason for their high average removal efficiency of lead and phosphate, allowing the higher surface area of the SCG-based electrodes to undergo more electrocoagulation reactions at a faster rate. These results are promising for the prospects of using waste materials in environmentally and cost-friendly industrial scale systems of water remediation.

## **A Colorimetric Intl1 Gene Gold Nano Sensor for Monitoring Environmental Wastewater Pollution**

*Adithya Iyer, Roanoke Valley Governor's School for Science & Technology*

The sheer number of bio-contaminants and their spread within wastewater sources poses a challenge for anthropogenic pollution monitoring. The purpose of this research was to develop, characterize, and functionalize an oligonucleotide gold nano sensor for colorimetric detection of the intl1 gene—a good proxy for wastewater pollution. Initially, 42 nm gold nanoparticles were developed via seed-mediated growth and characterized using UV-Vis spectroscopy, Dynamic Light Scattering, and Transmission Electron Microscopy. Then, the gold nanoparticles were functionalized using two cross-matching oligonucleotides. The environmental selectivity and stability of the gold nano sensors in nano pure water and wastewater were validated. In nano pure water, nano sensor selectivity was determined by incubating nano sensors in five separate intl1 and non-specific gene concentrations. This was repeated in landfill wastewater for three different intl1/NS gene concentrations. The stability of the sensor was assessed through gold nano sensor incubation in varying [MgCl<sub>2</sub>] solutions and different wastewater sources. The nano sensor was selective at 1 nM of the intl1 gene upwards for both nano pure and landfill water, and colorimetric detection via DNA hybridization was clearly observed. The nano sensors showed stability in [MgCl<sub>2</sub>] < 1 mM and were stable for 15 minutes in

wastewater effluent. Gold nano sensors serve as an effective model for environmental bio-contaminant detection due to efficient DNA hybridization with intl1 cross-matching genomic sequences. High nano sensor selectivity for the intl1 gene over short time periods in environmental wastewater conditions shows applicability even in wastewater effluent and high ionic concentrations. Gold nano sensors have clear promise for simple environmental pollution monitoring through distinctive colorimetric change and spectrophotometric analysis.

### **The Effect of Graphene Oxide Membranes on Ethanol Concentration**

*Sahil Jaiswal, Deep Run High School*

### **The Effect of Distance from Washington, D.C. on the Mercury Presence in the Potomac River**

*Laura Jayne, Washington-Lee High School*

The purpose of this experiment was to investigate mercury presence, a heavy metal, in water from different spots on the Potomac river at varying distances from Washington, D.C. It has been studied that because mercury and other heavy metals are present in sediment which can be pushed miles from its source by the Potomac's current. 6 locations were chosen along the Potomac river at 10 miles intervals from Turkey Run to Widewater State Park as levels of the independent variable. It was hypothesized that mercury would be found in the highest concentration in the water from the location that was furthest south. 6 glass jars and a water scooping apparatus were used to collect the water. Water testing strips tailored for mercury detection were used to take data readings. The results were organized into average mercury presence at each location, measured in parts per billion (ppb). Widewater State Park yielded the greatest average mercury presence by a small margin. Even though this fact supports the research hypothesis, the high standard deviations rendered the statistical differences insignificant. Additionally, the ANOVA test that was conducted showed that the null hypothesis couldn't be rejected. It would be beneficial in further investigations to utilize a more precise tool for measuring mercury presence in the water samples. Heightening awareness for the problem of Potomac River pollution and providing motivation for the implementation of an effective stormwater management system were the goals for this project.

### **The Effect of the Type of Stormwater Control System on Water Quality**

*Riley Johnson, Washington-Lee High School*

The Chesapeake Bay's water quality has decreased throughout the years because of pollution. Should this continue, the Chesapeake could be permanently damaged, harming its inhabitants and the United States. In order to prevent this, Arlington County, VA and others within the watershed have reformed their stormwater ordinances. This experiment was designed to study Arlington's new required stormwater control systems and observe the effects of the systems on water quality. This analysis will help to develop and improve the stormwater systems ensuring the best efforts in aiding the Bay's water quality. The hypothesis for this experiment was: if the type of stormwater control system is changed, then the bioretention basin will produce the least amount of erosion, turbidity, nitrate, phosphate, and a pH closest to 7. Four model stormwater systems were created and tested: piedmont soil combination (control), bioretention basin, bioretention planter box, and dry well. On the 14th day of the experiment the dry well had the lowest mean erosion

of 1.20 g; the bioretention planter box had the lowest mean nitrate of 0.32 ppm; the piedmont soil combination had the lowest mean phosphate of 0.026 ppm; and, the dry well had the lowest mean turbidity of 101.52 NTU. ANOVA tests were done and all dependent variables, other than pH and erosion, were significant having p-values less than the critical value of 0.05. While the data was significant, the hypothesis wasn't supported by the data. The final results helped to conclude possible ways to reform the systems for improvement.

### **The Effect of Water Purification Method on the Area of Bacterial Growth and the Level of Turbidity in Water after Purified**

*Brianna Kenealy and Laura Rapazzo, Washington-Lee High School*

### **The Effect of Lime Additive Amounts on the Bearing Capacity of Soils**

*Caroline Klotz, Clover Hill High School*

### **The Effect of Coagulants and Electro-coagulation on Remediation of Dye-polluted Wastewater**

*Parker Le, Mills E. Godwin High School*

The purpose of this experiment was to test the effects of natural coagulants and electro-coagulation on the remediation of dye-polluted industrial wastewater. Through the last few decades, textile industries have been increasing production to keep up with demand. A main issue is the disregard to the environment, specifically the water that is released from the factories. Dye-polluted water was purified with peanut powder acting as a natural coagulant, electro-coagulation, and a combination of both in an attempt to clean the water. It was hypothesized that the combination of both would produce better results than the electro-coagulation or natural coagulant separately. The results implied that the combination of both was significantly more effective than the other two levels. The mean also supported this, with both having the lowest mean absorbance. The results supported the research hypothesis. It is believed that the results are due to a greater amount of coagulant being used, with ions being release from the electrodes and the natural properties of peanuts purifying the polluted water. This research can lead to further studies involving different power outputs, different electrodes used, and other natural coagulants to achieve better results.

### **A Study of the Change in the Bacteria on Free Range Chicken Eggs Throughout the Seasons**

*Anna Lewis and Jerry Turner, Chesapeake Bay Governor's School for Marine & Environmental Science*

Almost every type of food goes through a process before it is sold in stores and eaten. Many of these processes can cause the food to grow unwanted bacteria. The purpose of this study was to quantify the amount and type of bacteria present on fresh chicken eggshells throughout multiple seasons. It was hypothesized that as seasonal temperatures increased, the amount and types of bacteria on the eggshells would also increase. Five fresh eggs were collected twice a month, from April to November. The eggs were then swabbed and smeared on five prepared Nutrient Agar plates and five EMB Agar plates. The plates were then placed in an incubator at a constant temperature of 37 degrees Celsius for 48 hours. Bacteria coverage on the Nutrient Agar plates was highest

in June and July with a downward trend from August to November. The plate coverage in April and May was slightly lower than the warmer months and higher than the cooler months. Plate coverage on the EMB Agar plates was similar to the seasonal changes from April to November with spikes in July and September, with a P-value of 0.007853, showing a notable difference. The number of types of bacteria on the Nutrient Agar averaged around four or five types with an increase to six types from August to October and provided a P-value of 0.040176 showing a significant difference. In conclusion, the amount of bacteria on the eggshells followed the trend of seasonal changes from April to November. The importance of this study is to identify the number of types and amount of bacteria on fresh chicken eggshells and how they change throughout the seasons. While not all the found bacteria is bad, Escherichia coli and Salmonella are two bacteria that can cause harmful infections. Knowing the conditions that might increase bacteria on eggs can be beneficial to those cleaning and preparing fresh eggs.

## **Environmental Science C**

### **Optimizing Metformin Removal: Utilizing Molecular Sieves and Absorbents within Sand Filtration Units**

*James Licato, Washington-Lee High School*

Diabetes is one of the most prevalent diseases on Earth. The most commonly used pharmaceutical to treat diabetes is metformin HCl. Attention and alarm over the environmental effects of this drug have increased because metformin has been found in our lakes, rivers, and drinking water. With known detrimental effects on aquatic organisms, including intersex and stunted growth, metformin's presence in the environment calls for a solution that can be implemented in water treatment. In this experiment, three aluminosilicates were tested for their effectiveness at removing metformin: two molecular sieves (zeolite Y, mordenite) and an absorbent (bentonite). These materials were tested under a variety of conditions within constructed sand filtration units to simulate tertiary stage wastewater treatment. Deionized water with metformin concentrations of approximately 400 ug/L were processed through the treatment systems. Sampling was done using liquid chromatography tandem mass spectrometry. Mordenite proved to be the most effective, removing 99.0% of metformin on average, compared to the control's 63.5%. Zeolite Y was 92.8% effective, and bentonite was ineffective. The channel and cage dimensions within the zeolite appear to be the reason for mordenite's high success, as mordenite's channel diameter is congruent to metformin's particle diameter, facilitating increased adsorption. By matching the channel diameter with particle diameter, mordenite could be utilized to remove metformin in water treatment. With an increasing number of pharmaceuticals posing an environmental threat, mordenite and other zeolites could potentially prove to be an inexpensive and easily implemented solution.

### **The Effect of Electricity on Magnetic Strength**

*Rowen Link, Mills E. Godwin High School*

This project was performed because of the increase of global temperatures known as global warming. The effects of global warming on a topic like magnets has not been investigated yet. So, the purpose of the experiment was to see if changes in temperature

would affect the strength of magnets. The hypothesis was that if the magnets were heated to 37 °C, then they would be the strongest. This was tested by using a cooling device for the control group, 14 °C, and a heating device for the 35 and 37 °C groups. Once the magnets reached their desired temperature, a magnetometer was used to measure their strengths. The results showed that the mean of the 37 °C group was visually the highest, while 35 °C was close and the control was much lower. Each of the groups had relatively large standard deviations and variances with only one outlier in all the data. When the inferential statistic tests were performed, the data was showed to be significant. Only the t-test between 35 °C and 37 °C had a lower value than the table value. The null hypothesis was rejected, and the research hypothesis was supported as 37 °C had a significant difference with the other two levels. These results are mostly due to the excitement of the particles of the magnets. As temperature increases, so did the particles' excitement. This caused them to have a stronger magnetic field. Some applications of the experiment are that if one knows the effect if these magnets, they can know what to expect in coming years due to global warming.

**The Effect of Volume of *Dactylis glomerata* Grasses Planted on Volume of Runoff**  
*Katherine Little, Yorktown High School*

**The Effect of Iron sulfate ( $\text{Fe}_2(\text{SO}_4)$ ), Aluminum sulfate ( $\text{Al}_2(\text{SO}_4)_3$ ), and Potassium manganate ( $\text{KMnO}_4$ ) on the Growth of *Acrochaetium***

*Anthony Marraccini, Central Virginia Governor's School for Science & Technology*

The purpose of this study was to determine which chemical (Iron Sulfate, Aluminum Sulfate, and Potassium Permanganate) had the most effect on the growth of *Acrochaetium*. This study was conducted at a local high school in December of 2018. Eight 2.5-gallon fish tanks each filled with saltwater and 21 clusters of algae. Two tanks were designated for each chemical and two for the control. The chemicals were applied to their assigned tanks and allowed to sit for two weeks, then the remaining living algae clusters were counted. The control group's mean was 21 clusters the Iron Sulfate group's mean was 13.5 clusters. The Aluminum Sulfate group's mean was 18 clusters. The Potassium Permanganate group's mean was 5 clusters. A one-way ANOVA with an alpha value of .05 was used to test the significance between the groups. The p-value was 3.14E-10, which was more extreme than the alpha value of .05. A post-hoc Tukey test showed that there was a significant difference between all groups. The results did not support the research hypothesis that Iron Sulfate would affect the algae more than Aluminum Sulfate and Potassium Permanganate, as they all significantly decreased the algae population. However, in summation, Potassium Permanganate affected the growth of *Acrochaetium* the most.

**Cycles of Growth in Long Lived Individual *Arctica islandica***

*Emma McKee, Chesapeake Bay Governor's School for Marine & Environmental Science*

The objective of this study is to examine long term changes in ocean quahog, *Arctica islandica* growth at three locations in the mid-Atlantic region, New Jersey, Long Island, and George's Bank, by observing the annual growth increments recorded in their shells. The overall hypothesis was as follows: the growth of all individuals in a population is

driven by local environment and therefore provides a synchronized record of environmental changes over its 100+ year life span of the quahog. Null hypotheses were that (#1) clam growth is consistent within a population, (#2) clam growth between populations is site specific, and (#3) clam growth will vary over time with long term environmental changes at all sites. Six quahogs were examined from each site and varied in age from 98 to 252 years old. All exhibited rapid growth for the first 10 years of their life followed by a long period of lower and decreasing growth rate corresponding to the period after reaching sexual maturity. An estimate of mean growth rate for the post-maturation period was made for each individual and compared to observed data. Thus, periods of faster and slower growth were recorded for each individual, and thus each population. These growth patterns allowed examination of the stated hypotheses. Null hypothesis #1 failed to be rejected by NJ and GB clams but was rejected for LI clams. Null hypothesis #2 failed to be rejected at all sites. Null hypothesis # 3 failed to be rejected at all sites. Observed growth patterns suggest that long term growth patterns at each site reflect site specific oceanographic conditions.

### **The Effects of Ambient Light Intensity of *Pyrocystis fusiformis***

*Renee Meade, Chesapeake Bay Governor's School for Marine & Environmental Science*

Photo-pollution is the presence of unnatural light in the night sky. It has the ability to disrupt the natural cycles of numerous organisms. In coastal areas, specifically near developed beaches, light pollution has major effects on marine life. Bioluminescence is the biochemical emission of light from an organism. Bioluminescent organisms such as *Pyrocystis fusiformis* can also feel the effects of light pollution. In 1943, Martin Burkenroad hypothesized that bioluminescence was a defense mechanism. This study observed the relationship between photo-pollution and bioluminescent dinoflagellates by looking at how they react to different intensities of ambient light. Five groups were cultured and tested by exposing the groups to no, low, moderate, high and full light intensity. Each group's bioluminescence was recorded in response to their specific intensity using a photometer. The duration of bioluminescence from each group showed a distorted bell curve with the highest time coming from high light intensities. However, the light produced showed an ideal bell curve with the moderate exposure producing the most bioluminescence. The p-value comparing intensity and exposure resulted in a value 0.001 being significant. However, the p-value comparing duration and exposure resulted in a value of 0.1859 thus being not significant. The study demonstrated a strong relationship between the intensity and exposure and a loose correlation between the exposure and duration of *Pyrocystis fusiformis*. Bioluminescence is most useful in areas of little to no light but photo-pollution can make it difficult to serve its purpose. If photo-pollution harms the natural cycle of bioluminescent organisms it could have negative on an ecosystem. Being able to understand the relationships between bioluminescent organisms and photo-pollution could allow for a healthy balance between the two.

### **The Effect of Antihistamines on the Heart Rate of *Daphnia magna***

*Ammy Medina-Centeno, Clover Hill High School*

### **The Effects of Ghost Fishing on Crab and Fish Populations**

*Jewel Mitchell, Chesapeake Bay Governor's School for Marine & Environmental Science*

Ghost fishing is when lost or discarded fishing gear is no longer under a fisherman's control and is also known as derelict fishing gear or DFG. The most common types of derelict fishing gear to ghost fish are gillnets and crab pots/traps, along with long-lines and trawls. Ghost fishing is a major problem in many ecosystems around the world. Like all types of marine debris, ghost fishing has a wide range of impacts on the environment, conservation of species, human health, tourism and local economies. This experiment was conducted over the course of three months in different areas of Perrin Creek in Hayes, Virginia. I found how three types of ghost fishing gear affect crab and fish populations because ghost fishing is a huge problem in a lot of ecosystems and its effects are harmful. Ghost fishing is detrimental to the health of humans, economies, the environment, and many species. There are no advantages if the crab and fish populations die from the impact of ghost fishing. The fisheries economy decreases, and humans are not able to benefit from the effect. The three types of gear are nets, hooks, and pots. I predict that pots will catch the largest amount of crab and fish populations because they capture organisms and are capable of self-baiting. I expected that hooks will catch the smallest amount because they cannot latch onto organisms easily. I've come to the conclusion that pots did catch the most, with nets coming in second, and hooks in last. In other words, my initial hypothesis was correct based on my data results.

**Periwinkle Site Fidelity at a Local Marina**

*David Mullins, Chesapeake Bay Governor's School for Marine & Environmental Science*

**The Effect of Salinity on the Growth of *Amphidinium carterae***

*Daniel Murray, Central Virginia Governor's School for Science & Technology*

The purpose of this experiment was to determine if ocean salinity had an effect on the growth of toxic algae that contribute to Red Tides in Southwest Florida. *Amphidinium carterae*, a marine dinoflagellate, was used as a model organism for *Karenia brevis*, the algae primarily responsible for Red Tide events off of Florida's Gulf Coast. *A. carterae* was grown over four and one-half weeks in tanks at salinities of 35 parts per thousand (ppt), 30 ppt, and 25 ppt. Ten one milliliter samples were taken from each tank approximately every seven days to be tested for absorbance levels in a spectrophotometer at 325 nm. The averages of all 10 samples were recorded. After running a linear regression on the final data set, a p-value of .0003 was produced. When compared to the alpha value of .05, the results were deemed statistically significant. The negative slope of the regression trend line supported the researcher's hypothesis that if salinity was decreased, absorbance would increase. The increase in absorbance as salinity decreased indicated that algae showed more growth when there was less salt in the seawater.

**The Effect of Body Cleansers on *Daphnia magna***

*Namit Nallapaneni, Mills E. Godwin High School*

The purpose of this experiment was to determine the effects of various body cleansers on the health of *Daphnia magna*. Pollution is currently one of the world's largest global killers and many are trying to combat its effects using campaigns and laws. Body

Cleansers are used every day, even though their ingredients are extremely harmful to the environment. *Daphnia magna* were exposed to a 9% solution of mouthwash, a 9% solution of hand soap, or spring water. The *Daphnia* were placed in the manufactured environment for 10 minutes and then the mortality rate was examined. The control used in the experiment was spring water. It was hypothesized that if *Daphnia magna* are placed in an environment that is 9% mouthwash then the specimen will die. The results revealed that all *Daphnia* exposed to a mouthwash solution were killed in a ten-minute period. Hand soap resulted in few deaths and spring water resulted in none. A chi-square test was done on the data and it was revealed that the data was significant for all independent variables against the expected frequency. The results did support the research hypothesis. It is believed that the results are due to the fact that mouthwash and hand soap both contain harsh cleansing chemicals that are known to be injurious. This study could lead to an investigation on other household pollutants. In addition, the experiment could advance to testing soap and mouthwash on less delicate organisms in future years.

### **The Effect of Type of Synthetic Fabric on Mass of Microfibers Released, when Washed**

*Angela Oandasan, Clover Hill High School*

### **The Effect of Bioplastic Composition on the Rate of Decomposition**

*Cy Pabis, Central Virginia Governor's School for Science & Technology*

The purpose of this study was to determine if the type of material a bioplastic is created out of affects its rate of decomposition. The research hypothesis was if a potato starch bioplastic, a corn starch bioplastic, and a petroleum-based plastic were placed in a soil environment, then the potato starch bioplastics would lose the largest percentage of mass by the end of the experiment. The plastics were cut into samples measuring 4 inches by 4.375 inches. Eight samples of each test group were placed in soil containers on iPower Seed Starter Heat Mats set to 35°C and watered with 180 mL of tap water three times a week over the course of the experiment. The mass of each sample was measured to find the average percent decrease of mass in each test group. The average decrease in mass was greatest in potato starch bioplastics at 11.8%, corn starch was the second greatest with a decrease of 7.6%, and petroleum-based plastics had no significant change. A one-way ANOVA test produced a p-value of 1.94E-19 ( $\alpha=.05$ ), resulting in statistical significance. A post hoc Tukey test determined that there was statistical significance between all test groups. The potato starch bioplastic average percent mass lost was the greatest, which supported the research hypothesis. In conclusion, potato starch bioplastics have a faster decomposition rate than corn starch bioplastics and petroleum-based plastics.

### **The Effect of Colloidal Silver on *Daphnia magna***

*Shaily Pal, Mills E. Godwin High School*

In recent years, nano silver has been implicated more in manufacturing because of its antimicrobial and antibacterial properties. However, the over usage of nano silver has resulted in pollution especially in aquatic ecosystems. The purpose of this experiment was to determine the effects of colloidal silver, containing nano silver, on *Daphnia magna*. Four different concentrations of colloidal silver, 0 µg/L (the control), 5 µg/L, 10 µg/L, 20



$\mu\text{g/L}$ , were made from 500 PPM colloidal silver and spring water and contained in 4 separate cups. A 500  $\mu\text{g/L}$  stock solution was made and contained in a fifth cup to make the concentrations. Thirty *Daphnia magna* were then dropped into the four testing concentrations and were recorded as dead or alive after 2 hours. It was hypothesized that the most *Daphnia magna* would die when exposed to the 20  $\mu\text{g/L}$  concentration. When comparing the mode of 0  $\mu\text{g/L}$  (alive), 5  $\mu\text{g/L}$  (dead), 10  $\mu\text{g/L}$  (dead), and 20  $\mu\text{g/L}$  (dead) it was observed that colloidal silver caused a dose-dependent mortality in *Daphnia magna*. A chi-square was done with the data revealing that all data was significant. The results were most likely due to the fact that nano silver's shape allowed it to interfere with the sodium transport of *Daphnia magna*. This allowed the nano silver to accumulate around the lungs and heart of the *Daphnia*, causing it to suffocate. For further investigations, the size and shape of nano silver should be tested for its toxicity on *Daphnia magna*.

### **The Effects of Location on Water Quality**

*Kayla Parada, Portsmouth STEM @ I.C. Norcom High School*

The purpose of this experiment was to determine the quality of different types of water with test strips, to make sure the water is safe for us to drink. The Elizabeth River and Lake Kilby water also went through a coliform test. I chose a sample from Lake Kilby, because that's where Portsmouth gets its water from and I chose a sample from the Elizabeth River, because the river flows through Portsmouth. If the water comes from the tap in Portsmouth, then it will not be contaminated. Every sample of water was tested with a NovoBlue test strip, which tested 14 qualities of water. They included hardness, pH, fluoride, iron, copper, nitrates, nitrites, free chlorine, total chlorine, bromine, cyanuric acid, carbonate, and total alkalinity. My hypothesis was proven, because the data I received from the test strips indicated there were no abnormalities in the tap water samples tested.

### **The Effects of Shallow Water Environments on Small Fish and Invertebrate Populations in the Chesapeake Bay**

*Nathan Parker, Chesapeake Bay Governor's School for Marine & Environmental Science*

Many shallow water fish and invertebrates in the Chesapeake Bay provide an essential link in the food chain between energy stored in plankton and energy in larger, more commercially important creatures. This study investigated the abundance, species richness, and Shannon Diversity Index biodiversity, for populations of small fish and invertebrates in different shallow water environments. Three types of locations were tested: Areas with marsh grass, areas with exclusively sand, and areas with riprap. For the totals of population abundance, species richness, and Biodiversity at the locations, it was hypothesized that marsh grass locations would have the greatest values, riprap would have lower values, and sand locations would have the lowest values. This was tested by first selecting locations of each of the three different types across two larger areas. Minnow pots were then placed in shallow water at the sites about an hour before low tide and picked up two hours later, and the fish and invertebrates caught were recorded. Ten samplings of each location were done through the summer. The results showed no significant differences in abundance, species richness, or biodiversity, but there did seem to be a trend of higher values in marsh grass areas. The abundances of

specific species in the different sites were also tested, and it was found that there were more of a type of common minnow in sand and marsh grass areas, and there are more grass shrimp in marsh grass and riprap areas. Marsh grass areas had high abundances of both species, so they can better support the link in the food chain between plankton and larger fish. Knowing where these important links in the food web are, can help us better plan how to use or preserve coastal regions of the Chesapeake Bay.

### **The Effect of Household Chemicals on the Heart Rate of *Daphnia magna***

*Aum Patel, Mills E. Godwin High School*

Runoff from roads is harmful to the ecosystem. Asphalt contains dangerous chemicals that can pollute water. The purpose of this experiment was to discover how the age and use of the road affects runoff pollution. The hypothesis for the age of a road in this experiment was if older pavement is tested then it will have the lowest concentration of pollution. The hypothesis for use of road was if less used pavement is tested then it will have the lowest concentration of pollution. The dependent variable for this experiment was the absorbance and the amount of pollution in the water being tested. The independent variables were the use and age of pavement. Six locations were visited, each location has a PCI. A PCI is a number 1-100 that determines the quality of the road. The highest PCI was 90, when testing the use of roads each road had a PCI of around 40-50. Roads are separated into four categories for use of road. Neighborhood minor, neighborhood principle, minor arterial, and other principal arterial. The roads that were tested for age were all neighborhood principles. A spectrophotometer and logger pro were used to figure out how much pollution was in the water. Each set of data was a graph, the point that was measured was on the highest point on the graph which was the ABS. The ABS was the amount of absorbance in the water. The lower the ABS the less pollution. The null hypothesis was rejected therefore the data was significant. The hypothesis for use of pavement was incorrect, the less used pavement had the most pollution compared to medium use and heavy use. A possible explanation for this is that because the pavement was newer the chemicals from the asphalt had not been washed away yet. So, when it started the rain some of the chemicals had been pushed into the storm drains. The hypothesis for the age of the pavement was incorrect, however, the older road had less pollution than the medium road but more than the new road.

### **Sand Characteristics and Erosion Potential in a Nourished Beach Environment**

*Kayla Paulos, Chesapeake Bay Governor's School for Marine & Environmental Science*

Beach nourishment is a process of pumping sand from offshore reservoirs back onshore, which replaces the volume lost to shoreline changes from erosion and sea level rise. Beach nourishment is costly considering it must be repeated regularly, at least once every decade in each area of the Outer Banks, for it to be effective and keep up with natural rates of erosion and the rising sea level. This study looks at sand on Outer Banks beaches over approximately a 19 mile stretch to determine the characteristics of the nourishment sand. Five different beach sites on the Outer Banks, North Carolina were chosen for sampling. These sites were selected because they were all places where beach nourishment has recently occurred. Intertidal sand samples were all collected from October 22 through October 24, 2018. A Hjulstrom diagram was used to show where sediments will erode, transport, and deposit. It was found that the average flow velocity

in the Outer Banks is approximately 30-100 centimeters per second and the average grain size found on the nourished beaches is 0.3-0.5mm, the sediment will be always eroding and being transported according to the diagram. According to the results of the data from this study, changing the grain size of the nourishment sand will not prevent erosion. Based on these results, local communities need solutions for increasing nourishment longevity. Dare County and similar coastal areas like Virginia Beach should invest in their own equipment to save money, and then beach nourishment can take place more often and as needed.

### **The Effect of Various pH on Fruit Fly Larvae**

*Thuc-Uyen Phan, Mills E. Godwin High School*

### **The Effect of Cigarette Butts on Brine Shrimp in an Aquatic Environment**

*Anna Pitts, Chesapeake Bay Governor's School for Marine & Environmental Science*

An estimated 37.8 million adults in the United States smoke cigarettes and nearly 766,571 metric tons of cigarette butts are found as litter yearly. Studies have shown that chemicals in cigarettes can be harmful to humans and other animals. This study compared different concentrations of smoked cigarette butts on organisms low on the food chain in an aquatic environment. Artemia, or brine shrimp, were used in this study. Two experiments were conducted using Instant Ocean added to four 2-liter bottles of water and a different number of smoked cigarette butts (2 butts, 4 butts, 8 butts, and a control with no butts) were added to select bottles. After a week an equal amount of brine shrimp cysts were added to the bottles. In the first trial, 2 samples were measured and 3 samples in the second trial resulting in 5 total samples for each experimental group. Every day for a week 3-5 mL samples were collected, depending on the experiment, and, using a microscope, the number of eggs, live shrimp, and dead shrimp were recorded, and the percent hatched and percent mortality were calculated. Results were not significant for hatching but were significant for mortality. Since mortality was shown to be higher for samples with more butts, it shows that cigarette butts do in fact have an effect on brine shrimp life. Cigarette waste is harmful to organisms low on the food web and could have cascading effects. Limiting pollution from cigarettes in all environments is important in order to prevent toxicity to organisms, especially in important environments like the Chesapeake Bay.

## **Environmental Science D**

### **The Effect of Tree Cover Loss and Population on Air Quality**

*Mahia Rahman and Belen Tesfaye, Washington-Lee High School*

The purpose was to evaluate if tree cover loss and population density contribute to air pollution. Finding the exact impact tree cover loss and population density have on air quality in the US can inform strategies on how to combat air pollution. The hypothesis was if both tree cover loss and population increase, then air quality will decrease. The independent variables were the added amounts of tree cover loss in 2001-2017 and population from 2017. The dependent variable was the Air Quality Index (AQI). Tree cover loss and population data were collected for the 50 states in which each state was a trial. Tree cover loss density and population density, both per square mile, with their corresponding AQI were divided into 4 groups, high and low. t-tests with equal variances

and correlation tests were conducted for the 2 groups. The t-test of high tree cover loss vs. low tree cover loss had a p-value of  $1.01 \times 10^{-1}$  which was not significant. The correlation test for tree cover loss vs. AQI was negative (R-squared = 0.0056). The t-test of high population vs. low population had a p-value of  $1.31 \times 10^{-2}$  which was significant. The correlation test for population vs. AQI was positive (R-squared = 0.067). The hypothesis was supported by the population results, as it was significant. It was concluded tree cover loss was not significant due to the quantification of tree cover loss rather than the amount of tree cover. Further experimentation was conducted. The same procedures were done but with 2010 data for both tree cover and AQI. The t-test of high tree cover vs. low tree cover had a p-value of  $6.98 \times 10^{-1}$ , which was not significant. The correlation test for tree cover vs. AQI was negative (R-squared=0.0271). It was concluded tree cover loss and tree cover is not the main contributors to air quality as other factors can be taken to account.

### **The Effect of Antecedent Soil Moisture on Topsoil Runoff**

*Laurel Seay, Central Virginia Governor's School for Science & Technology*

The purpose of this study was to determine if pre-existing soil moisture had a direct affect the amount of topsoil runoff. Seven models were built to mimic a local environment and current flash flood. Equal amounts of clay soil were distributed in each model, and then soil moisture levels were measured using a Vernier soil moisture meter probe. There were three moisture levels measured, 4.3%, 9.8%, and 14.3%, with seven trial runs per condition. Each condition was then flooded with 2500 mL of water and runoff was collected and measured. The mean amount of runoff was 192.0 mL for the 4.3% moisture level, 187.9 mL for 9.8%, and 295.0 mL for 14.3%. A single-factor ANOVA determined significance, with a p-value of .0013 and an alpha value of .05. The post-hoc Tukey test determined which values had significance, with a D min value of 69.6. My Tukey test showed that the 14.3% moisture level showed a statistically significant difference, however the conditions of 9.8% and 4.3% did not. All moisture levels supported my research hypothesis, that the topsoil containing the highest amount of pre-existing moisture would result in greater amounts of soil runoff, except the 9.8% level. In summation, antecedent moisture levels affected the amount of runoff in two out of the three tested conditions.

### **The Effect of Time and Combinations of Meteorological Variables on the Accuracy of Deep-learning-predicted Dry Bulb Temperature**

*Fareed Sheriff, Mills E. Godwin High School*

The purpose of this study was to determine which combination of commonly used meteorological variables correlates most closely with dry bulb temperature. The rationale of this experiment was that determining which combination of commonly used meteorological variables could have identified which portions of physical weather models should have been improved. The real-world implications of this were that identifying which portions of physical weather models should have been improved could have made weather forecasting more accurate, increasing the chance a natural disaster was identified and preparations made ahead of time, thus decreasing potential lives lost due to weather-related phenomena. The hypothesis stated that the level of the IV with the highest correlation of all of the levels was the “time, barometric pressure, and humidity”

level. There was no control in this experiment because there was no level of the IV that acted as a baseline for the rest of the levels. The procedure for this experiment involved downloading meteorological data, programming and training an artificial neural network, and compiling and analyzing the results. The results showed that the pressure and humidity level and the wind speed and pressure level both correlated the most directly with dry bulb temperature and the pressure and humidity level correlated the least directly with dry bulb temperature.

### **The Effect of Sterilization Methods on Coliform Presence/ Absence**

*Nate Stevenson, Mills E. Godwin High School*

### **Seasonal Populations of Gelatinous Zooplankton in Local Estuaries**

*Payton St. Louis, Chesapeake Bay Governor's School for Marine & Environmental Science*

The gelatinous zooplankton population fluctuates naturally with seasons and water conditions, but due to human influence recently this population has been increasing rapidly worldwide (Codon, 2012). The most prevalent gelatinous zooplankton taxa in the Chesapeake Bay are: from the phylum Ctenophora, *Mnemiopsis leidyi* and from the phylum Cnidaria, *Cyanea capillata* and *Chrysaora chesapeake*. Cnidarians are more specialized, and require specific salinity and temperature ranges, they are more stenohaline and stenothermal, for example *Chrysaora chesapeake* can only survive in salinities between 10 and 16 ppt and temperatures between 25 and 30° C (Mills, 2001). Ctenophores, on the other hand, are super adaptive and can survive hypoxic conditions and a broad range of temperature and salinity. To increase the knowledge on the seasonal abundance of gelatinous zooplankton in the lower Chesapeake Bay region known as the Middle Peninsula, this study recorded the abundance of Ctenophores and Cnidaria over one year. The study took place at two different test sites: the Piankatank River and the Corrotoman River. Each sampling date, Cnidarians were counted based on a visual assessment, while Ctenophores were recorded based off of a population captured with a net. The population of Ctenophores was scaled based on a subsample captured with the net in the area. The scaled value was the ctenophore count multiplied by a factor of 100 to represent a more accurate scaled value over the same size area observed for Cnidaria. Based on the data collected, it can be determined that the Ctenophore population is abundant all year and regardless of environmental factors. The Cnidarian population is very dependent on both temperature and salinity, and the varying species of Cnidarians have evolved to emerge in different environmental terms. In the Chesapeake Bay, there is an imbalance of Ctenophores and Cnidarians related to Cnidaria habitat loss of oyster reefs. The large abundance of Ctenophores are an indicator of the depletion of oyster reefs, and decreasing water quality. Without a stable ecosystem, the marine environments ratio shifts from vertebrates to invertebrates, which is not useful in maintaining a productive food web (Steinberg, 2018).

### **The Effect of Different Clothing Fibers on the Amount of Microplastics Collected**

*Emilio Tognelli, Arlington Career Center*

Are microplastics dangerous to the environment? The purpose of the experiment was to find which type of common clothing fiber would release the highest number of

microplastics when washed. This experiment was conducted to bring awareness to an issue that is not commonly talked about and to gain more knowledge about the problem. The purpose was to see whether rayon, nylon or polyester would release more fibers. This experiment was tested by washing each individual type of cloth, filtering it, then examining under a microscope to count the number of microplastics that were caught in the filter. The major findings of the experiment were that the nylon cloth ended up releasing the most fibers while polyester released the least. This data disproved the hypothesis because more nylon fibers were found instead of polyester fibers. These results also disprove the null hypothesis which was, that the fibers would release the same number of microplastics.

### **Analyzing the Difference in the Sorption Concentrations of Copper, Lead, Iron, and Zinc in Polylactic Acid and High Density Polyethylene Plastic Bags**

*Rose Tomiak, Southwest Virginia Governor's School*

The detrimental impact of plastic bags on our planet's environment has negatively impacted the health of plants and animals around the world through physical harm, like entanglement, and chemical harm, such as exposure to toxic chemicals and carcinogens. High density polyethylene, the most commonly used plastic in shopping bags, is one of the highest contributors to plastic pollution. Polylactic acid, a polymer derived from corn and other natural sources, has recently been used as a cleaner alternative to high density polyethylene. However, no research had been conducted to determine the sorption qualities of this plastic. The objective of this study was to examine the sorption properties of polylactic acid plastic as compared to high density polyethylene plastic to determine if bags made from polylactic acid absorbed a higher, more dangerous concentration of heavy metals. Both plastic types were soaked in a solution containing iron and copper and then analyzed and compared using an atomic absorption spectrometer. After subtracting the concentration of treated samples from the concentration of untreated samples, the high- density polyethylene plastic samples absorbed a mean concentration of 0.464 parts per million for copper and 34.152 parts per million for iron. The polylactic acid samples absorbed a mean concentration of 0.669 parts per million for copper and 35.024 parts per million for iron. A matched pairs analysis of the data produced a p-value of 0.0102 for copper and 0.0075 for iron which allowed the null hypothesis to be rejected. The polylactic acid samples absorbed a significantly higher concentration of both iron and copper than the high- density polyethylene samples. The results indicated that polylactic acid plastic use in the commercial industry is not recommended due to its ability to sorb copper and iron. Further research should be conducted in order to determine the leaching and sorption properties of this plastic with other metals or organic compounds.

### **Analysis and Comparison of Ibuprofen and Triclosan on the Growth and Germination of *Pisum sativum***

*Reilly Towns, Mills E. Godwin High School*

Recent findings have shown that many pharmaceuticals and personal care products (PPCPs) such as triclosan and ibuprofen are discharged into the environment due to incomplete removal during wastewater treatment. In previous research, triclosan and ibuprofen have been found to absorb into various plants. Moreover, triclosan has been found to have toxic effects on plant growth, and ibuprofen has been observed to stimulate

plant growth. This experiment studied the effects of various concentrations of triclosan and ibuprofen on germination and growth of pea plants (*Pisum sativum*). *P. sativum* were exposed to 0, 1, 10, and 20 mg/L of triclosan or ibuprofen, then measured for their height. The final number of plants germinated was also recorded. It was hypothesized that if *P. sativum* are exposed to various concentrations of triclosan, then exposure to 20 mg/L will result in the least germination and the least growth, and that when exposed to the same concentrations of ibuprofen, exposure to 20 mg/L would result in the most germination and growth. The results showed that 20 mg/L had the second lowest average height, and the second least germination. The data revealed that 20 mg/L of ibuprofen had the lowest average height and the least germination. The research hypothesis was therefore not supported. A t-test revealed that the majority of data were not statistically significant, and most likely due to chance or error. Error sources may have included human error in measuring plant height, incomplete dissolution of both compounds in water, degradation of triclosan, and under watering due to restricted access to the school lab. Further research may include studying the reactions of different plants to ibuprofen and other commonly detected contaminants, and long-term effects of ibuprofen and triclosan on subsequent generations of plants.

### **The Physiological Effect of Microplastic on *Daphnia magna***

*Alyssa Underwood, Central Virginia Governor's School for Science & Technology*

The purpose of this research project was to find out if the presence of microplastic caused a significant increase in the heart rate of *Daphnia magna*. The *D. magna* were divided up into eight beakers with 10 *D. magna* in each. Each group contained two beakers with varying concentrations of microplastic. The controls had 0 g/L of microplastic, the low concentration had 200 g/L, the medium concentration had 300 g/L, and the high concentration had 500 g/L. Every few days, four *D. magna* would be removed from each beaker and heart rates recorded under a Zeiss Primostar microscope. An ANOVA performed with the average heart rates from each group in trial one, trial two, and both trials averaged together produced results that were not statistically significant. The alpha value was set at .05, the p-value from the trial one data was .210, for trial two was .064, and both trials averaged was .207. The research hypothesis, which predicted that a high concentration of microplastic would result in a significant increase in heart rate in *D. magna*, was not supported by the data. This experiment was an investigation into the environmental impact of plastics on aquatic organisms.

### **Application of Microbial Fuel Cells in Detecting Water Pollution**

*Anna Vargas, New Horizons Governor's School for Science & Technology*

The purpose of the experiment was to expand upon the ultimate goal of creating a Microbial Fuel Cell (MFC)-based biosensor through a Proof of Principle. The MFC was tested with an opening and closing anode and an open cathode in the controlled environment of a backyard pond. The student utilized a self-built single-chamber (open-cathode) MFC to discover the effect of different amounts of liquid fertilizer in water samples on the electrical output of an open-cathode microbial fuel cell. The anode and cathode were connected together by a salt bridge, and both sides were exposed to carbon cloth electrodes. To test the electrical output, the students used a multimeter to record electric voltage and adjusted the nitrogen and phosphorus content in the pond in intervals

of 0, 10, 20, 30, 40, 50 drops of liquid fertilizer, administered in intervals every week during a 6 week period. The voltage, weather, and water temperature were recorded every 24 hours from the start of the experiment. The first week was important in determining that the electrical values could sustain a constant electrical voltage to provide a comparative baseline for subsequent tests with agricultural fertilizer. This test proved that an open-cathode MFC can provide a constant electrical voltage, though within a certain range and only after an acclimation period and revealed that the novel MFC responded to changes in agricultural fertilizer with significant sensitivity. This experiment ultimately indicated the MFC's feasibility as a biosensor.

### **The Effect of Soil Conservation Methods on the Amount of Soil Eroded**

*Joe Vimalathithan, Clover Hill High School*

### **The Effect of the Age and Use of Pavement on the Amount of Pollutant Runoff into Storm Drains in Arlington, VA**

*Rose Von Eckartsberg, Yorktown High School*

Runoff from roads is harmful to the ecosystem. Asphalt contains dangerous chemicals that can pollute water. The purpose of this experiment was to discover how the age and use of the road affects runoff pollution. The hypothesis for the age of a road in this experiment was if older pavement is tested then it will have the lowest concentration of pollution. The hypothesis for use of road was if less used pavement is tested then it will have the lowest concentration of pollution. The dependent variable for this experiment was the absorbance and the amount of pollution in the water being tested. The independent variables were the use and age of pavement. Six locations were visited, each location has a PCI. A PCI is a number 1-100 that determines the quality of the road. The highest PCI was 90, when testing the use of roads each road had a PCI of around 40-50. Roads are separated into four categories for use of road. Neighborhood minor, neighborhood principle, minor arterial and other principal arterial. The roads that were tested for age were all neighborhood principles. A spectrophotometer and logger pro was used to figure out how much pollution was in the water. Each set of data was a graph, the point that was measured was on the highest point on the graph which was the ABS. The ABS was the amount of absorbance in the water. The lower the ABS the less pollution. The null hypothesis was rejected therefore the data was significant. The hypothesis for use of pavement was incorrect, the less used pavement had the most pollution compared to medium use and heavy use. A possible explanation for this is that because the pavement was newer the chemicals from the asphalt had not been washed away yet. So when it started the rain some of the chemicals had been pushed into the storm drains. The hypothesis for the age of the pavement was incorrect, however, the older road had less pollution than the medium road but more than the new road.

### **Is There Evidence of Male Limitation in the Summer Blue Crab Fishery?**

*Sarah Walton, Chesapeake Bay Governor's School for Marine & Environmental Science*  
Watermen are harvesting blue crabs, oysters, and fish in their respective seasons, year over year and overharvesting can cause fishery failures and broad ecosystem consequences. Imbalances in the number or size of each sex in the population could result in reproductive failures and damage to both the ecosystem and the fishery. This



study examined the abundance and sizes of male and female crabs as well as the ratio of both sexes caught in the commercial fishery over the months of June, July, and August in 2018. All blue crabs were harvested in commercial crab pots during the hard crab season in the lower Rappahannock River in Middlesex County, Virginia. Blue crabs were collected twice a month from June to August. Each day's sample was pulled from crabs caught over 50 crab pots fished in a commercial method. All of the males and females caught in the 50 pots were counted separately and 12 crabs of each sex selected randomly from each day were measured and recorded. This study can help further the knowledge of the future of the blue crab fishery and the population dynamics of the blue crab.

### **The Eelgrass Microbiome: A Study of Microbial Development in Restored *Zostera marina***

*Tahi Wiggins, Chesapeake Bay Governor's School for Marine & Environmental Science*

The benefits of the Chesapeake Bay, both to humans and the environment, are widely touted, as is the dire need to mitigate stressors to its ecosystem. Of the many relationships present in the Bay, that of marine plants and microbes is relatively understudied, yet microbes may play a significant role in the vitality of submerged aquatic vegetation (SAV), specifically eelgrass, which has been in decline since 1990 and subject to restoration efforts beginning in 2001. This study aimed to examine the development of the microbiome of restoration eelgrass beds by comparing diversity and composition of microbial presence between two beds of different developmental stages (17 and two years after planting, respectively) located in Cobb and Spidercrab Bays off the Eastern Shore of Virginia. Microbial composition and diversity, as well as relative percentages of classified taxa abundance, were compared between location through sediment DNA extraction and 16S rRNA gene sequencing analyses. Microbial richness was significantly higher in the more developed Cobb bed ( $p = 0.020$ ) as well as diversity estimated by a Shannon Diversity Index ( $p = 0.011$ ). While there was no trend in overall composition, seven bacterial genera (of the over 1,800 analyzed) compared independently were deemed significantly different between the two beds. The inferred metabolic potentials of selected genera (anaerobic vs. aerobic) proved not to be a factor. The complex results of this study demand further speculation and experimentation in order to further understand the complex relationship between developing SAVs and the microbes they host.

### **The Effect of the Intensity of Nighttime Light Pollution on the Survival Rate of Ladybugs**

*Shenandoah Worrel, Clover Hill High School*

### **Investigating Coral's Appetite for Plastic**

*Virginia Worrell, Southwest Virginia Governor's School*

Plastic poses a severe threat to coral and the ecosystems for which coral reefs provide vital needs such as food and protection. Plastic ingestion by coral has been observed in numerous studies but is poorly understood. Is there a certain type of plastic that coral prefers to ingest? Is there a certain component or stimulant in plastic that is attractive to coral? To test this, *Acanthastrea lordhowensis* (acan coral) were exposed to three different types of microplastics (<5mm)--polypropylene (PP), low-density polyethylene

(LDPE), and polyvinyl chloride (PVC)-- to see if there was a preference toward a certain type. No ingestion was observed using the primary method therefore, the method was altered so that trials only lasted for a duration of 60 minutes and coral were observed for the entirety of the trial. Hooks were produced so as to hold the positively buoyant plastic within reach of the coral's tentacles for the duration of the trials. Using the secondary method, significantly more PVC was ingested than the other types of plastic. However, it is possible that the corals were not equally exposed to the three types of plastic due to the difference in buoyancy. It is possible that negatively buoyant plastic poses a larger threat to coral in its natural environment in the ocean because it stays within reach of the coral's tentacles. The correlation between coral species and plastic type preference need to be further investigated in the future.

### **The Effect of Permeable Pavement Type on the Amount of Water Absorbed into the Ground**

*Rose Yang, Mills E. Godwin High School*

### **Sunscreen Efficacy by Chemical Composition and Its Effect on Aquatic Life**

*Taylor Yates, Chesapeake Bay Governor's School for Marine & Environmental Science*  
Sunscreen provides protection against skin cancer by reducing UV exposure to the skin. Active ingredients come in two basic forms, chemical and mineral; ongoing research indicates that some active ingredients in sunscreen are harmful to marine life. This study is an analysis of chemical and mineral SPF 30 sunscreens to determine which provides the highest efficacy for skin protection while also providing the lowest toxicity to aquatic organisms. Sunscreen efficacy was tested by exposing photoreactive chemical paper applied with chemical and mineral sunscreens to the sun. Results of the photo effect paper trial showed a wide variation in the efficacy of SPF 30 rated sunscreen, ANOVA  $p=2.3E-09$ . Aquatic algae and mosquito larvae were exposed to a series of 6 different test solutions of sunscreens and a control over a 72-hour period. Results of showed statistically different effects of the 6 test solutions, with ANOVA  $p=0.0358$  for mosquito survival and ANOVA  $p=6.27E-07$  for the algae test. This study has demonstrated that brand reported sun protection factor is not accurate or consistent for all sunscreens tested. The results support other published research that indicates that the active ingredients in sunscreen can potentially cause significant harm to organisms in the environment.

### **Human Behavior**

#### **The Effect of Music Tempo on the Effectiveness of Studying**

*Jonathan Bierly, George H. Moody Middle School*

Listening to music while studying is a common practice that many follow and knowing whether or not it actually has an effect is an interesting question. Music can easily be analyzed into how many beats it has per minute. This is called tempo. The purpose of this project was to determine how different tempos affect the success of studying, and if faster, or slower, tempos are better. It was hypothesized that when listening to faster music, test scores would decrease, and that the effect of the music tempo would be the same on both males and females. 20 subjects studied multiple subjects while listening to different

tempo music. The music tempos were 61-85, 86-110, 111-135, 136-160, and no music. They listened to each song for three minutes while studying the test, and then had three minutes to complete it. The results from the experiment revealed that subjects performed worse when listening to faster tempo songs, with the average score being 38.23. The data also showed that participants performed better when listening to low tempo songs, with the average score being 52.35. This supported the research hypothesis, that stated when subjects studied while listening to lower tempo music, they will perform better. Based on the average test scores collect, a direct correlation can be seen between music tempo and test score. Before it can be concluded that faster tempo songs are strictly worse for studying, the multiple test would need to be analyzed to make sure they all are equal difficulty.

### **Computer Versus Paper Testing**

*Sophia Carney, Mary Ellen Henderson Middle School*

The research objective of this experiment was to examine whether the medium used to take a test affects how students perform on that test. The experiment was administered by having seventh grade students answer test questions from past Virginia Standards of Learning (SOL) tests given to eighth graders. A higher than grade-level test was used to allow for greater differentiation in the students' scores. The independent variable in the experiment was the medium the test was taken on--that is on paper versus a computer. The dependent variable was the students who were taking the same test in different formats. During the first round of testing all students took the same test in a paper format. In the second round of testing all students took the same test, but this time only half the students took the test on paper while the other half took it on a computer. The idea was to see if students performed consistently between the two rounds without regards to the medium of the test. When taken on paper the difference between the first test and second test scoring was -4 which means they did an average of four points worse on the second test. When taking the second test on computer the participants scored an average of 8.75 points better. My results showed that certain students performed significantly better on the second-round test when taken on the computer compared to their peers who took both tests in written format. This did not support my hypothesis.

### **The Effect of Song Genre on Earworm Likelihood**

*Elizabeth Coe and Tara Udani, Gunston Middle School*

The experiment's purpose was to research and test the effects of different music genres on the likelihood of involuntary musical imagery (songs stuck in your head, also known as earworms) for each genre. The researchers' approach to this experiment was to use sample songs for each genre (Pop, Rock, Rap, Classical and Country) and play them for the test subjects. They had the test subjects record any song, whether or not it was the test song, that was in their head. The test songs are the starter songs to get the participants started on the experiment, not the test songs of the entire experiment. The project is testing the genre, not each individual song. This way, the researchers could tally the number of songs per genre, per person. The outcome of this experiment was that the genre pop was the most likely to become an earworm, while the least likely earworm was classical. The researchers discovered that pop was the most common earworm because of the frequency of pop songs on the radio, the popularity of pop with the test

subjects, and the music patterns. They also discovered that classical was the least common earworm because it tends to be less upbeat, less frequently played and listened to.

### **The Effect Background Music on Reading Speed**

*Joseph Cohen, Sabot at Stony Point*

This experiment was performed to determine which type of music is the least distracting while trying to read. The experiment was done on 20 adults. Each person had to read four passages from Mark Twain's Tom Sawyer with a different type of music in the background. The time taken to read each passage was timed from start to finish for each trial and then the words per minute were calculated. There were four passages for each person, and a total of 20 tests. After all the trials were completed, the data showed that on average, reading with the control (no music) was equal to reading with ambient music or classical music (no significant difference). Popular music was the only type of music that was shown to significantly affect people's reading speeds.

### **Fidget Wars: The Effect of Fidget Toys on the Concentration of School-age Children**

*Fares Elsherbiny and Caleb Morgan, Louise Benton Middle School*

The purpose of this project is to determine if fidget toys can be used as a tool to help students focus more when they complete their schoolwork. Essentially, the authors conducted two experiments to compare the results of both. They tested and studied the results of students diagnosed with Attention Hyperactivity Disorder (ADHD) and those without the disorder. They developed two different hypotheses: The first one is if students with ADHD use fidget toys while taking a test, then their ability to focus will increase. The second one is if students without ADHD use fidget toys while taking a test, then their ability to focus will decrease and they will become distracted by the toys. To determine if the hypothesis was correct, an experiment was conducted and a total of 60 school-age children (4-17) were given basic concentration tests with and without fidget toys. As a conclusion, the first hypothesis was determined to be correct, and the second hypothesis was determined to be incorrect. Fidget toys, especially Fidget Spinners, on average helped all students improve their test scores, both with ADHD and students without the disorder.

### **The Effect of Vehicle Type and Color on Vehicle Speed**

*Ryan Ermovick, Kenmore Middle School*

This experiment was conducted to see if vehicle type or vehicle color has an effect on how fast a vehicle, on average, is traveling. There are two hypotheses of this experiment. The first hypothesis is "If the vehicle is a sedan (independent variable), then it is more likely to go faster (dependent variable) than other vehicle types." The second hypothesis is "If the vehicle is black (independent variable), then it is more likely to go faster (dependent variable) than other vehicle colors." This experiment was conducted on a specific residential street in Arlington County, Virginia. On nine separate occasions, and at various times, data on vehicle speed, vehicle type, and vehicle color was collected. In total, data on 1,194 vehicles was recorded. The results show that the vehicle type with the highest average speed was the sedan category, and the vehicle color with the highest

average speed was the blue/purple category. The first hypothesis, about vehicle type, was accepted, but the second hypothesis, about vehicle color, was rejected.

### **The Effect of Auditory Distractions on Task Efficiency**

*Oliver Frankel, Sabot at Stony Point*

Many people get distracted while doing work. The work can go from finding a YouTube video to writing a senior thesis but there will still be distractions. If the distractions are disruptive but can be eliminated, it would be easier to work without them. In this experiment, answers were found on how distracting every-day noises are. Sixteen participants were asked to perform a Boggle-like test with grids for them to find words to write down. The average scores with distractions and without distractions supported the idea that every-day noises affected task efficiency. However, based on variability, due to the lack of a trend with or without distractions, the results were more likely caused by the participants' ability to find words, rather than the distractions affecting them.

### **Praising Children for their Intelligence: Constructive or Destructive?**

*Alexandra Funk, Mary Ellen Henderson Middle School*

The goal of the experiment was to find how different levels of praise affect how children perceive setbacks. The data was collected through two tests that were given to 12 test subjects. The data was analyzed by comparing the time taken on each test and score improvements. Test subjects that were given praise on the first test on effort were more likely to see a setback on a second test as a lack of effort. Those praised for their intelligence saw that their lower score on the second test was because they weren't smart enough. Everyone who was praised for effort chose to take home a copy of the second test. These results could be interpreted to mean that those who are praised for effort attribute success to effort, thus will try harder on assignments in the future. Other studies have shown the same results.

### **The Effect of the Amount of Time Video Game Played in the Last Week in Hours on the Person's Reaction Time**

*Qingyuan Hu, George H. Moody Middle School*

Video games have grasped many present-day teenage minds, and many adults think their children are too addicted to these action-filled video games. However, others claim that video games do have benefits, including improving reaction time. The experimenter decided to perform this experiment to see if there were actually any benefits to playing video games and if the claims were true or false. The experimenter's hypothesis was, "If the amount of time video game played in the last week in hours increases, then the person's reaction time in milliseconds is shorter." Twenty voluntary participants were first asked to sign the Human Informed Consent Form to participate in this experiment. Then, the experimenter tested the participants' reaction time five times using an online reaction time test while recording each of the five scores as the pretest scores. Afterwards, the experimenter assigned the participants to play the video game Tetris for 0, 1, 2, or 3 hours during the following week. At the end of the week, the experimenter would test all the participants' reaction time again five times and collect each of the scores as the posttest scores. On average, the participants who played three, two, and one hours of Tetris lowered their reaction time by 78 milliseconds, 26 milliseconds, and 11 milliseconds,

respectively. However, the reaction time of the participants who played zero hours did not change significantly. These results and other scientific principles showed that the experimenter's hypothesis was correct and video gaming does lower a person's reaction time.

### **The Effect of Physical Fatigue on REM Sleep**

*Amrit Kundan, George H. Moody Middle School*

### **The Effect of Timed Math Problems on Heart Rate**

*Brady Lang, Sabot at Stony Point*

The experiment tested the impact of timed and untimed tests on heart rate. How this was performed was participants took two tests one timed for one minute and one untimed and then their heart rate was recorded after the test. The hypothesis for this experiment is that if the participant is timed then their heart rate will rise. The data showed a consistent increase except for 3 people in heart rate. The average non-timed heart rate was 83.8 beats per minute (BPM) and the timed average was 87.95 BPM. In conclusion, the impact of timed tests on heart rates were lower than expected, but in the end the heart rates are generally higher.

### **The Effect of Bergamot Oil on Critical Thinking**

*Marissa Milton, Sabot at Stony Point*

Many students struggle with doing their best on tests because of sleep deprivation or having a challenge focusing. Aromatherapy is a common way to improve attention and focus. Different essential oils are used for aromatherapy and bergamot oil is one that is claimed to improve focus. The purpose of this project is to use bergamot oil for aromatherapy purposes and as an aide to students during tests. In this experiment, twenty participants were asked to take two critical thinking tests. The first test was done with no added scents or intentional distractions, then the participants were given a break and shortly after, they took the second test with bergamot essential oil being diffused in the air. The results of this experiment rejected the hypothesis which was that the essential oil would increase cognition. The results showed that bergamot essential oil decreased the participants ability to correctly answer critical thinking questions. Fifteen of the participants had higher scores when the essential oil was not being diffused. Three of the participants scored with a larger amount of correct answers with essential oil and two participants scored equally on both tests.

### **The Effect of Bilingualism on One's Divergent Thinking**

*Risshi Naavaal, George H. Moody Middle School*

The purpose of this study was to see if there is a correlation between bilingualism and one's divergent thinking. The term bilingualism means being able to know two languages. Divergent thinking refers to the cognitive process that generates ideas. The research hypothesis was that the bilinguals would exhibit a higher level of divergent thinking compared to the monolinguals. Fifty participants in total were recruited to take part in the study, 25 for each language group. A test was developed (unusual uses test) to determine the participant's divergent thinking. This test had three questions and the participants had three minutes to complete it. Each participant's responses for all three questions were

summed together, resulting in their final score. Once the data collection was finished, the mean, median, and mode was calculated. A two-sample homoscedastic student's t-test was also conducted to see if there was any statistically significant difference between the two groups at a 0.05 level of significance. The participants all attended middle school and their ages ranged between 11 and 14 years. Majority of bilinguals were Asians and majority of the monolinguals were Caucasians. The average number of responses by bilinguals were 14.00 and monolinguals was 12.24. However, according to the t-test, the two groups did not differ significantly in their divergent thinking ( $p=0.207$ ). Based on this study sample, there is no significant relationship between bilingualism and divergent thinking. More research needs to be conducted to understand the impact of number of languages spoken on divergent thinking.

### **The Effect of Nanometer Frequencies on Circadian Rhythm and Retina Physiology**

*Nihal Pothunoori, George H. Moody Middle School*

The circadian rhythm, the corporeal schedule for any living species, actuates based on exposure to daylight and relies heavily on dormancy at night. Sleep is the result of melatonin production (a hormone in your brain released during night) but can unfortunately be intruded easily, due to artificial lights such as blue or yellow light. The greater the nanometer frequency is, the easier the light can be exposed to your eyes in larger quantities such as the case of a 400 nm difference from artificial blue to yellow light. When exposed to during nighttime, these lights result in a loss of sleep and a slow deterioration of eyesight. This knowledge led the experimenter to an alternative hypothesis: if a greater nanometer frequency is exposed to the retinas, then both sleep quantity and retinal perception will decrease compared to exposure to a lower nanometer frequency. A sleep log was then created, and twenty-five individuals were contacted, with the request to log forty days of sleep. Each participant was appealed to expose themselves to thirty minutes of either blue/yellow/no light and to record sleep quantities. For the testing of the retinal photoreceptors, an optometrist was contacted and gave the opinion that over a period of forty days, no measurable significant change would occur. After all the sleep logs were collected, results showed that yellow and no light led to a twenty percent increase of sleep than blue light, and the difference from before and after nine when exposed to blue light was ten percent. As hypothesized, blue light had a more detrimental effect on sleep than yellow/no light. This data has the means to persuade device manufacturers to revert all their products to a yellow light and increase productivity in general and increase understanding of bodily functions. The community can also benefit from this experiment by using the information proceeding from this paper to create a graph about sleep and time schedule for better productivity and sleep.

### **The Effect of Aging on Memory**

*Saniya Sangle, George H. Moody Middle School*

### **The Effect of Different Actions Taken While on a Screen on Difference in Visual Acuity**

*Aashka Shah, George H. Moody Middle School*

Eyesight plays a very important part in everyone's life, and electronic screens may be making it worse. The increased time spent on screens for daily activities has led to complaints about eye strain and poor eyesight. The purpose of this experiment was to find out the best way to preserve eyesight while on a screen. In order to test this, the eyesight of 15 subjects was tested before and after 15 minutes of screen time on an iPhone 6. The difference between visual acuity before and after screen time was calculated using a Snellen chart. Each subject was tested once for each independent variable: no actions (the control), blinking often, looking away, and wearing anti-glare glasses. Everything except the actions was kept constant to collect accurate data. The hypothesis was if the action taken while on a screen was blink often then the visual acuity would have decreased by the least. The results showed that the mean visual acuity change for no actions was 2.7 m and 2.8 m for the right and left eye respectively. For blink often the mean difference was 0.4 m for the right eye and 0.1 m for the left eye. For look away the mean visual acuity change was 0.4 m for both eyes. For wearing anti-glare glasses, the mean change of visual acuity was 0.6 m for the right eye and 0.9 m for the left eye. The ANOVA test found a significant difference ( $P < 0.05$ ) between one or more of the actions. The Tukey test found that there was a significant difference between all the actions compared to the control. There was not a significant difference between the actions, not counting the control, compared to each other. The mean difference for blink often was the least though. In conclusion, the results partially supported the hypothesis by showing that the mean change for blink often was the least, even though there was not a significant difference between blink often and the other actions. Other studies and this study show similar results, completing these actions improve eyesight.

### **The Effect of Choice on Happiness**

*Katarina Shilland, Gunston Middle School*

### **Which Type of Humor will Invoke the Most Laughter in 7th Grade Students?**

*Jana Simmons, Indian River Middle School*

A scientist conducted an experiment on which type of humor would invoke the most laughter in Seventh-Grade students. People laugh for a variety of reasons. The scientist tested 14 students total. This scientist hypothesized that the seventh graders would laugh the most at physical humor. This hypothesis was not supported. Physical humor scored an average of 1.8 laughs out of 14 students. The scientist found that dark humor invoked the most laughter with an average number of laughs of 4.3. Wordplay invoked the least number of laughs with an average of 1.7.

### **The Effects of Multitasking**

*Kathryn Snyder, Mary Ellen Henderson Middle School*

Multitasking is a daily occurrence for many people around the world. But is it really multitasking? The purpose of the experiment was to discern whether multitasking is actually productive or just splitting your concentration. The experiment was conducted by giving the test subject a number of tasks to perform until they messed up. The Independent Variable in the experiment was the tasks being performed. The first level was writing 'the' continuously on a sheet of paper. The second was the first task and pressing a button in the pattern one, one-two. The third level was both tasks one and two



and reciting the pledge of allegiance. The Dependent Variable was the number of seconds it took for the test subject to mess up. The results were quite interesting. The test subjects with three tasks messed up sooner. The graphs show that when one task is being performed, the productivity and preciseness of the tasks increases compared to when multiple tasks are being performed. For instance, the average amount of time for someone performing one task was 98.78 seconds, whereas the average for someone performing two tasks at a time is 76.38 seconds. And the average while performing three tasks at a time, was 47.65, drawing even more of a gap between the levels of the experiment. The experiment shows that multitasking decreases productivity and preciseness of the tasks being performed.

### **The Effect of Time on the Reliability of Eyewitnesses**

*James Teague, Mary Ellen Henderson Middle School*

The experiment was conducted to determine how the reliability of eyewitnesses in criminal court cases change after the passage time. The independent variable was the passage of time measured in days, and the dependent variable was the participant's ability to remember the photo displayed to them and the distinct features of the man in the photo. The experiment was conducted by asking participants to view a photo closely for 2 minutes and remember the skin, hair and eye color of the participant and 2 other distinct features of their choice. Then the participants return in 2, 4, 8, 16 or 32 days later (depending on independent variable group) and remember the skin, hair and eye color of the participant and the other 2 previously stated distinct features. After that, they would identify the photo they originally saw in a lineup of 8 other photos. A linear regression equation was created to make reasonable predictions based on data gathered. The linear regression equation resulted in  $y = -0.9879032258x + 106.25$ . According to this trend, the participant would not be able to remember any feature of the man in the photo after 108 days. The data concludes that at or around 27 days an eyewitness would not be able to provide a reliable eyewitness account of the features of a person who has committed a crime. An eyewitness would be able to identify a potential suspect in a lineup of suspects, but not describe the features of them if the suspect is presented at around 32 days. It is also important to note that the photo lineup results are irrelevant if police cannot find the culprit, which without physical evidence they would need an accurate description and without 100% of features remembered by an eyewitness that would be difficult to accomplish.

### **The Effect of Different Color Texts on the Speed of Reading**

*Navya Thoota, George H. Moody Middle School*

The majority of the world's printed and online articles consist of black lettering, while it might not be the most ideal or effective color to use for the evolving minds of young children, and the fully developed minds of adults. People tend to associate different colors with different meanings and emotions. Red means stop, green means go, and yellow means slow down. Darker colors usually translate to darker moods, and lighter colors do the opposite. A change in text color could increase the speed of reading. The purpose of this experiment is to help teachers and pupils. With a color of text that is faster and easier to read, educators and students could be more efficient during the school year. They could cover more material and learn at a faster rate. 25 females of ages 11-13 read the

same passage with five different color texts. Red, blue, green, yellow, and black as the control. Each person read the passage out loud and was timed with a stopwatch. The size and font of the text were consistent throughout the trials. After conducting the experiment, black text had the lowest average by 2 seconds. Its average fell at 18.43 seconds. Red, blue, and green text all had around 20 seconds, and yellow text had 21.65 seconds. While the experiment was conducted well, improvements to the process could have been made. Since the same passage was used for each trial, the reader became more fluent every time they read the passage. If another experiment similar to this was to be conducted, the experimenter should use a list of words in an inconsistent pattern.

### **The Effect of Dark Chocolate on the Short-term Memory in Adolescents 13-14 Years Old**

*Ryan Wen, George H. Moody Middle School*

The research presented at Experimental Biology 2018 annual meeting in San Diego suggested that chocolate with a minimum of 70% cacao could support cognitive, endocrine, and cardiovascular health. Blood tests revealed that that chocolate influenced gene activity, increased anti-inflammatory agents, and increased infection-fighting cells. Further research suggested that dark chocolate could positively impact brain function, such as cognitive function and creativity. The purpose of this project was to determine how the following dark chocolate dosages would affect the short-term memory of adolescents: 0 Hershey Kisses, 2 Hershey Kisses, 4 Hershey Kisses, 6 Hershey Kisses, and 8 Hershey Kisses. The five groups were tested in the same sterile and anti-distracting environments and given 30 seconds to consume their dosage of dark chocolate. Then given 30 seconds to memorize as many words from the word lists as possible before they get 30 seconds to think and then asked to write down as many words as they remember from the list in 30 seconds. The results indicated that the group that received the highest dosage (8 Hershey Kisses) with a mean number of recalled words of 7.35 and then the group that received the lowest dosage (0 Hershey Kisses) with a mean number of recalled words of 4.6. An ANOVA test was conducted between the means of the groups (G5 vs. G4 p-value=0.465776 G4 vs. G3 p-value= 0.000159 G3 vs. G2 p-value= 0.798337, G5 vs. G3 p-value=<0.00001 G4 vs. G2 p-value=0.000175 G3 vs. G1 p-value= 0.004716). The data supported the research hypothesis that if the group consumed 8 Hershey Kisses, then they would've been able to recall the most number of words. Based on the number of words recalled determined in this research, there appears to be a direct correlation between the dosage of dark chocolate and the number of words recalled from the vocabulary lists. To be concluded, an increase in the dosage dark chocolate Hershey kisses has a positive impact on the short-term memory of adolescents ages 13-14.

### **Math: Patterns and Relationships**

#### **The Effect of Different Banks on the Amount of Accumulated Money with Interest Rate in a Standard Savings Account**

*Afrin Akhtar, Kenmore Middle School*

The issue of trusting a bank to give optimum service is a dilemma currently surrounding the economy. The amount of accumulated money in a savings account can vary depending on the bank. Being aware of how much currency can accumulate in a bank

can help people profit in the end. I intended to see which bank accumulated the most money and which one accumulated the least in a standard savings account. The independent variables are the banks, BBVA Compass, Capital One, Marcus by Goldman's Sach, Wells Fargo, and CIT. The dependent variable is the amount of accumulated money assumed to be at the end of 30 years. I began by creating a calculator that converts Annual Percentage Yield (APY) to an interest rate. Then I converted the APY into interest rate and inputted the information into an interest calculator along with compounding time, the number of years, and the deposit. I hypothesized that Wells Fargo was going to accumulate the most amount of money, assuming their interest rate would be higher in a standard savings account due to the scandal suffered by the company in 2016. The hypothesis was rejected due to the fact that Wells Fargo had the lowest interest rate compared to the other banks.

### **The Effect of Media on Voting in the Greater Richmond Area**

*Eilaf Aljasari, George H. Moody Middle School*

### **The Effect of Average Daily Temperature on Total Crime Rates per Day**

*Maya Jones, Thomas Jefferson Middle School*

### **The Effect of Different Average Income per Capita Levels on the Suicide Rate**

*Grant Lee, George H. Moody Middle School*

### **The Effect of Distance Travelled on Home-field Advantage in Soccer**

*Lucas Orthober, Sabot at Stony Point*

### **Math: Theoretical and Modeling**

### **The Effect of Surface Angle on the Width and Length of a Simulated Blood Drop**

*Emma Berver, Washington-Lee High School*

The purpose of the experiment was to determine the effect of changing the angle of the surface on the width and length of the subsequent blood drops. The accuracy of the angle of impact equation used in forensics to determine the angle a blood drop was falling at, when it hit a surface, was also tested. To find the angle of impact, the width of the simulated blood drop was divided by the length to find the arcsine. It was hypothesized that if the angle of the surface is increased, the width of the simulated blood drops would decrease, and the length would increase. After completing the experiment, it was found that as the angle increased the simulated blood drops elongated because the length increased, and the width decreased. For example, the group with a surface at  $10^\circ$  had a mean width of one centimeter and a mean length of 1.01 centimeters, while the group with a surface at  $80^\circ$  had a mean width of 0.4 centimeters and a mean length of 2.28 centimeters. So, the data supported the hypothesis. The angle of impact equation was generally accurate, and if added to the angle the surface was approximately  $90^\circ$ . Such as in the  $80^\circ$  level, since the angle of impact equation equaled a mean of  $10.16^\circ$ ,  $80^\circ$  plus  $10.16^\circ$  equals approximately  $90^\circ$ .

## **Qualitative Analysis of Stability and Robustness of Domestic Flight Schedules**

*Gavin McCabe, Jacob Rice and Kai Vylet, New Horizons Governor's School for Science & Technology*

Unforeseen flight perturbations cause inconveniences for passengers and airport personnel and large profit losses to flight carriers. Identification of schedules that effectively mitigate the damage caused across an airport network would benefit customers and industry. A model was created to evaluate the robustness of a particular schedule. The simulation utilized a Boolean network approach to pass flight and delay data between nineteen nodes that represent individual airports. The simulation ran over the course of 24 hours subdivided into one-minute intervals. Schedules with various compactness and flight volumes were simulated and the total network delay was measured using the average value of the system metadata. The schedules returned average metadata values of 164, 530, and 762 respectively with higher metadata values indicating greater total network delay. The graph behaviors for the low compactness (80%) schedule recovered well from delays after peak hours and returned to a state of almost no delay by the end of the day. In contrast the higher compactness schedules (90% and 95%) did not recover from delays after peak hours and ended the day in a state of delay. The results suggest more compact schedules elongate delays and cause a less stable system, while the less compact schedules sufficiently dissipate these delays and create a stable system.

## **The Effect of Alignment Algorithm on Identification of Microbial Pathogenicity**

*Cameron Sharma, Mills E. Godwin High School*

Humans have a complex relationship with microbes. Microbes live on the surfaces of our bodies as beneficial microbiota. However, sometimes those microbes acquire disease-causing changes. For example, the K-12 strain of E. Coli living in our gut helps extract energy from fiber and prevent colon cancer but the O157:H7 strain causes serious diarrhea and kidney failure. The purpose of this experiment was to study the effect of different multiple sequence alignment (MSA) algorithms on identifying microbial pathogenicity. The metagenomic model developed in this research can help classify unknown bacteria (e.g. find the source of an E. coli outbreak). The levels of independent variable were consistency, iterative, progressive and structural methods. The accuracy of finding pathogenic strains was the dependent variable. Progressive method was the control variable. It was hypothesized that the progressive method would give the best fitting MSA. The MSAs were constructed from bacterial 16S rRNA protein sequences. The test data points were created by bootstrapping the raw data. Custom developed computer code and online bioinformatics tools were used for the project. The mean values for the independent variables were 52.272, 54.720, 64.637 and 67.993 PMM units. The corresponding t values were higher than the table t value of 2.011. Therefore, the null hypothesis was rejected, and the results were significant. The results supported the hypothesis since progressive alignment had the highest PMM scores. Flaws in sequences in the databanks is a possible source for error. A new hybrid progressive algorithm invented here produced the best results. The metagenomic model created in this research identified E. coli strains with 97.39% accuracy. The model serves an unmet need and is well suited for medically underserved areas such as poorer communities worldwide and remote locations. The work could be extended to other organisms in future.

## **Music on Math - The Mathematical Basis of Musical Chords**

*Ameya Sinha, Yorktown High School*

## **Combatting Gerrymandering Using Mathematical Methods to Define Compactness and Account for Natural Boundaries**

*Maria Stuebner, New Horizons Governor's School for Science & Technology*

## **Interactive Storyteller to Improve Student Engagement and Performance**

*Reid Tenzer, Roanoke Valley Governor's School for Science & Technology*

## **The Effect of Sentence Characteristics on Readability and Text Ranking**

*Lindsey Wang, Chantilly High School*

## **Medicine and Health A**

### **The Effect of Varying Concentrations of Sodium nitrite on the Regeneration Lengths of Planaria**

-The purpose of this study was to determine if sodium nitrite, a common meat preservative and suspected carcinogen, affects the growth of planaria during regeneration. Planaria were used as a model organism for human cells in this experiment. The planaria were bisected with a scalpel into anterior and posterior sections. Each section was placed in a well plate cell containing either a low (0.0018 mg/mL), medium (0.0028 mg/mL), high (0.0038 mg/mL), or no concentration of sodium nitrite. Each concentration group was made up of four anterior and four posterior planaria sections. These concentrations were calculated using the LD50 on the SDS sheet for sodium nitrite. Their lengths were measured under a LEICA EZ4D light microscope with a millimeter ruler throughout the course of nineteen days. The initial measurement was subtracted from the final measurement to calculate the total growth over the regeneration period. This data was analyzed using a one-way ANOVA inferential test, resulting in a p-value of .11, which is higher than the set alpha value of .05. Therefore, the data did not support the research hypothesis and the null hypothesis was retained; there were no statistically significant differences between the concentration groups. Therefore, the concentration of sodium nitrite does not affect the regeneration length of planaria. It can be supported by the data that sodium nitrite does not increase the rate of cell division, which can cause cancer. Thus, according to this study, sodium nitrite is not a potential cancer-causing agent.

### **The Effect of Varying Concentrations of Sucrose on the Fecundity of *Drosophila melanogaster***

*Callie Booth, Central Virginia Governor's School for Science & Technology*

The purpose of this experiment was to determine if sucrose consumption adversely affects the fecundity of *Drosophila melanogaster* and therefore, humans. The study was conducted in a local high school laboratory from November 2018 to February 2019. Virgin female flies were separated into two groups: one with no added sucrose and one with 5% sucrose in the food medium. The female flies consumed their assigned food for two days, had 24 hours to mate with male flies, before having an additional 24 hours to lay their

eggs. The flies with no added sugar produced an average of 47.25 eggs per fly while the flies with 5% sucrose in their food medium produced an average of 18.3 eggs per fly. With this data, a 2-sample t-test produced a two-tail p-value of .0025. Because it was lower than the alpha value of 0.05, it produced statistically significant results. Therefore, the research hypothesis that stated if *Drosophila melanogaster* are given varying amounts of sucrose in their diets, the group with the most sucrose would produce the least amount of eggs, was supported. In conclusion, the amount of sucrose in the diet of *Drosophila melanogaster* had a significant effect on fly fecundity and provides insight into how obesity caused by a high-sugar diet affects humans

### **The Effect of Pulsed Electromagnetic Field Exposure on Planaria Regeneration**

*Audrey Carlson, Central Virginia Governor's School for Science & Technology*

The purpose of this experiment was to determine the effect of different frequencies and time exposure of a pulsed electromagnetic field on the regeneration of *Dugesia dorotocephala* (planaria). The planaria served as a model for bone regrowth in humans. Twenty planaria were divided into five groups and each group was subjected to a different combination of frequency and exposure time of radiation. The original length of each planaria was recorded. All samples were transected, resulting in head and tail segments. All planaria except the control group were exposed to the electromagnetic field for a 15-day period. The total growth was calculated using the difference between the final and original length measurements. The average total growth of the control group was .125 mm and the average total growth of the four testing groups was .566 mm. An ANOVA one-factor test returned a p-value of .650 and an ANOVA two-factor test returned a p-value of .771. The p-value results were compared to a chosen alpha value of .05. The ANOVA test results were found to be not significant, therefore the research hypothesis, which stated that if the planaria are exposed to the PEMF at a frequency of 36 Hertz for one hour every day during a 15-day period, this exposure will promote faster regeneration in planaria than without exposure, was not supported. In conclusion, ANOVA-based data analysis of the different tested PEMF frequencies and time exposure did not show a statistically significant effect on *Dugesia dorotocephala* regeneration.

### **A Novel Approach to Identifying Inhibitors to Neurodegenerative Prion Misfolding Using AutoDock Vina**

*Nikhil Challa, Mills E. Godwin High School*

The simulations run on AutoDock Vina program display the binding score of each compound to PrPC (normal prion protein) and PrPSc (bovine prion protein), the purpose being to achieve the desired result of a lack of potency towards PrPC and high potency towards PrPSc. Neurodegenerative diseases caused by prion misfolding garner attention as incurable diseases that are highly prevalent amount in the United States. Screening for pre-existing compounds to combat prion misfolding is quick and relatively cost-effective, in stark contrast to funding and time required to develop a cure. Using AutoDock Vina, compounds were minimized and docked within the active sites of PrPC and PrPSc, and the binding scores in kcal/mol were given as the simulation expired. Pentosan polysulfate, one of the leading compounds against PrPSc, was hypothesized to achieve the desirable result. Results from simulations revealed only four drugs that were ranked above pentosan polysulfate, indicating the accuracy of PrP literature reviews. The data

for PrPC and PrPSc underwent a paired two sample t-test for means and was determined significant at a level of 0.01. The results also showed a prolific correlation between higher ranking and the original purpose of the compound as an anticoagulant/inflammatory agent, with three of the top five ranked compounds described as such. This computer simulation provides the blueprint for further testing of these compounds in vitro and in vivo to confirm results.

### **Role of EphA4 in Vascular Gene Expression during Inflammation**

*Michael Chen, Blacksburg High School*

EphA4 is essential in the development and recovery of the cerebrum during trauma. EphA4 is a member of the EphA4 subclass of Eph receptors and can bind to both Ephrins A and Ephrins B. Previous studies have shown that EphA4 is critical in the development of neuronal connectivity as well as synaptic plasticity, vascular formation, axon regeneration and repair of the central nervous system. Increased EphA4 and pro-inflammatory gene expression is correlated with increased brain injury severity in patients. Studies show that EphA4 is expressed profoundly in areas of inflammation within the cortex. However, its role in mediation of inflammation remains unclear. Previously it was shown that suppression of EphA4 after an injury to the brain resulted in a reduction of damage and attenuation of the inflammation. To test the role of EphA4 in inflammation, VTM-EEK (VTM) and KYL were utilized to inhibit EphA4 gene expression and lipopolysaccharide (LPS) was used to simulate an inflammatory environment. 300,000 endothelial cells were plated into a gelatin-coated 6-well plate and four treatment groups were created: LPS-, LPS+, VTM+LPS+, KYL+LPS+. Quantitative real-time polymerase chain reaction (qPCR) was conducted and data was gathered using GraphPad Prism, version 7 (GraphPad Software, Inc., San Diego, CA). Our data demonstrate brain-derived endothelial cells show reduced pro-inflammatory mRNA expression following EphA4 suppression via VTM peptide inhibition or genetic knockdown. This data demonstrates that EphA4 is a novel regulator of inflammation in endothelial cells within the brain.

### **The Effect of Individual Probiotics and Combinational Probiotics on *Drosophila melanogaster* Reproduction and Longevity**

*Bennett Clark, Mills E. Godwin High School*

### **The Effect of Toothbrush Design on the Splaying of Bristles**

*Jared Conway, Clover Hill High School*

### **The Effect of Advertised Use Time on Dissolution Rate of Antihistamines**

*Jack Dwyer, Mills E. Godwin High School*

This experiment was conducted to find out whether antihistamines advertised to work for 12-hours act faster to relieve allergies than antihistamine advertised to work for 24-hours. It was hypothesized that if 12-hour use antihistamine is tested then it will dissolve faster than a 24-hour use antihistamine. The speed at which the tablets dissolved was determined by placing them into a synthetic stomach acid solution and filming the process to determine how long each tablet took to dissolve. No control was used for this experiment because there is no standardized tablet to compare them against. From the experiments it was determined that, on average, 12-hour use dissolve faster than 24-hour

use antihistamine tablets. It should be noted that although the means show one acts faster than the other, a t-test revealed that the data was not significant, and therefore more likely due to chance than due to the independent variable. From the data it is concluded that more research is needed to fully determine whether 12 or 24-hour use antihistamine works faster. For further investigation it would be recommended to test other brands or types of antihistamines, and use a more standardized dissolving procedure

### **The Effect of the Menstrual Cycle on the Risk of Knee Injury in Females**

*Madison Gallagher, Central Virginia Governor's School for Science & Technology*

The purpose of this study was to determine whether or not the menstrual cycle has an effect on the likelihood of a female injuring her knee. The project was initiated by finding participants from colleges and universities. Once consent had been gathered from the participants, the electronic survey was sent. It asked the participant to indicate the date of injury and the nearest period. From there, each participant was given a number based on how many days post-period the injury occurred. This number was then used to determine which stage of the menstrual cycle each participant was in at the time of injury. The results were not significant. Due to the small sample size and having to discount data points for inconsistencies, a statistical analysis was not possible. The research hypothesis, which stated that if the rates of joint injury are compared across the menstrual cycle then the follicular stage will have the highest rate of injuries, was not supported. While the data was not significant, this project opens up the possibility of more research into this topic. With better tools and more time, a more accurate understanding of the relationship between the menstrual cycle and knee injuries could be possible.

### **The Effect of Sensitive Detergents on Skin Irritability**

*Serena Grant, Mills E. Godwin High School*

The purpose of this study was to determine whether there is a significant difference between various laundry detergents that are advertised for sensitive skin. In this experiment, pig skin, acting as the human skin substitute, was left overnight with a piece of cloth washed in one of the detergents. A better analysis of the detergent cannot be performed because of the enzymes present in the detergent compositions, but the qualitative data and observation-based analysis contribute to the experiment's real world application, which is to determine if one detergent is less irritating than the others. Different detergents and levels of the IV used were Free and Gentle (A), Free and Gentle High Efficiency (B), Purclean (C), and Original Scent (D). The brand was Tide. The hypothesis was that if four pieces of cloth washed with different detergents are laid on pig skin for 24 hours, then the high efficiency sensitive detergent will have the highest irritability rating among the sensitive detergents. The control was detergent D because it was advertised as the standard detergent. The cloth samples were cut from t-shirts washed in their own load with their assigned detergent, then cut in the lab and placed in petri dishes overnight with pig skin also cut at the lab. Observations were recorded and chi-squares were performed, and none of the differences in detergent were significant.

### **The Effect of Various Essential Oils versus the Antibiotic Vancomycin on the Growth Inhibition of *Staphylococcus epidermidis***

*Katie Harrison, Central Virginia Governor's School for Science & Technology*



The purpose of this experiment was to test whether essential oils could be an alternative treatment to expensive antibiotics for *Staphylococcus epidermidis* as model bacteria for methicillin-resistant *Staphylococcus aureus* (MRSA). Standard aseptic technique was used during the trials, along with spread plate technique to inoculate the bacteria. The efficacy of various essential oil treatments (*Leptospermum scoparium*, *Thymus vulgaris*, *Melaleuca alternifolia*, and *Eucalyptus globulus*), the antibiotic vancomycin, and distilled water, was measured by the zone of inhibition. The average means of the essential oils were higher than the average mean of the antibiotic. *T. vulgaris* had the highest mean with 54.25 mm, *M. alternifolia* had 35.25 mm, *E. globulus* had 34.38 mm, *L. scoparium* had 26.25 mm, while vancomycin had 25.25 mm, and distilled water expressed no zone of inhibition. The data was analyzed with a one-way ANOVA using an alpha value of .05, which produced a p-value of 6.95E-09, thus indicating that the data was statistically significant. Subsequently, a post-hoc Tukey Test was run. This revealed that all of the treatments (essential oil and antibiotic) were statistically significant to distilled water. Furthermore, *T. vulgaris* was statistically significant to all of the other treatments. The research hypothesis that *L. scoparium* would be the most effective treatment was not supported; however, essential oils overall showed more efficacy than vancomycin, with *T. vulgaris* being particularly significant. This could help people by offering a less expensive, and perhaps more effective treatment, for MRSA.

### **The Effect of Auricle Shape and Angle of Hearing on the Amplification of Sound**

*Luke Hatch, Central Virginia Governor's School for Science & Technology*

This study was conducted in order to investigate the relationship between auricle shape and angle of hearing, and the resulting amplification of sound from these variables. Through testing the hypothesis, an auricle with increased depth and height in various areas would perform best, data supported the optimal angle being 135°, contrary to the hypothesized 90° angle. Testing was performed with four different auricles, at three different directions. Each ear was mounted on an insulated box placed .5m away from the sound source, a speaker playing a 50dB sound at a frequency of 261.6 Hz. Inside the foam-insulated box was a Vernier Sound Level Meter measuring the received decibel level that travelled to the ear and in the canal. Eight trials were conducted for each auricle shape and each direction, and numbers were then averaged. A two-factor ANOVA was then ran resulting in p-values of 3.95x10<sup>-72</sup> (angle), 3.24x10<sup>-28</sup> (ear shape), and 1.09x10<sup>-9</sup>(interaction) ( $\alpha=.05$ ). After promising results from the ANOVA, a post-hoc Tukey test revealed 93.9% significant data, with the raised and lowered auricle performing best at all angles, however optimal at 135°. Overall, ear shape as well as direction were found to have a profound effect on how an ear is can amplify sound.

### **Computer-aided Discovery of NDM-1 Inhibitors to Reverse Antibiotic-resistance**

*Christopher Heron, Mills E. Godwin High School*

### **Rehearsed Memorization's Effects on Voice Recognition in Alzheimer's Patients**

*Charlie Jones, Southwest Virginia Governor's School*

In 2014, the CDC reported that almost 5 million Americans were living with Alzheimer's disease, a neurodegenerative form of dementia that causes loss of memory, social skills, and motor functions. Despite the prevalence of this disease, there is not a cure;

consequently, this has led to massive amounts of research into possible treatments. One such treatment was investigated by Dr. Michelle S. Bourgeois when she investigated flashcard's effects on memory retention. She discovered that flashcards help patients retain more analytical data like names, numbers, and facts. In this project, the researcher built on prior experimentation and tested whether rehearsed memorization through digital flashcards could improve voice recognition in Alzheimer's patients. The researcher designed a digital survey which asked users to listen to audio clips of famous voices and match the appropriate picture to the respective voice. A random sample of students under age 18 and a sample of the elderly were further divided into a "Reviewing" group and a control. Both groups took a pre and post-test one week apart, but the "Reviewing" group studied flashcards for 30 minutes each day between the tests. The differences between the mean scores and times of completion were analyzed with an ANOVA test which yielded no significant difference between those who reviewed and those who did not. Thus the researcher failed to reject the null hypothesis that rehearsed memorization has no effect on voice recognition in Alzheimer's patients. The failure is most likely attributed to a small sample size, a short time span, and the independence of the survey which added many unintentional variables. Although this experiment showed insignificant results, the importance of investigating treatments to improve the quality of life for those with Alzheimer's and other dementias grows as the population continues aging. Hopefully, further study can provide some hope for individuals and families struggling with an otherwise grim diagnosis.

### **The Effect of Natural Materials on Prevention and Management of Radiation Dermatitis**

*Sreedhatri Kandlakunta, Mills E. Godwin High School*

This experiment was performed to investigate the effects of natural substances on the prevention and management of radiation dermatitis. Turmeric possesses anti-inflammatory, anti-carcinogenic, and antioxidant properties, along with being a radio and chemo sensitizer, hence, one of the reasons it is commonly investigated for medical purposes. *Aloe vera* is also known as a medicinal plant, due to the fact that *Aloe vera* possesses antioxidant, anti-inflammatory, and anti-allergic properties. If natural materials have a significant effect, further studies could be done to incorporate natural substances in treatment plans for a variety of diseases. The study included a control of no treatment and experimental groups that received turmeric and *Aloe vera* treatment. It was hypothesized that the turmeric would be the most effective. The experiment was conducted by creating an agar skin simulation, applying *Aloe vera* and turmeric treatments, and exposure to UV radiation, after which the percent of damage to the agar was calculated. The results showed that the turmeric had the lowest average percent of damage, supporting the hypothesis. The t-test performed showed that two of the calculated t-values were greater than the table t-value and the probability of error was less than 0.01, proving the data to be statistically significant. It is believed the results are due to the fact that turmeric in its purest form has the greatest amount of chemical compounds at their highest performance rate. Suggestions to improve this study may be to use animal skin cells or a more complex skin simulation.

## **Using *Drosophila* as an Integrated Model to Elucidate the Neuropathy and Cellular and Genetic Mechanisms Underlying Traumatic Brain Injury (TBI)**

*Shan Lateef, Thomas Jefferson High School for Science & Technology*

Background: Traumatic brain injury (TBI) is a leading international cause of morbidity and mortality. The neurologic outcome of TBI is significantly influenced by the cellular and molecular responses (secondary injury) to the initial impact, which are poorly understood. The goals of this project were to: 1) To assess the level of apoptosis by immunolabeling cleaved Caspase-3 activity in whole *Drosophila* brains, subjected to TBI, 2) To utilize qRT-PCR and quantify the level of expression of 2 antimicrobial peptides (AMP) genes (Attacin C and Diptericin B) after TBI, thereby assessing the role of the innate immune response, and 3) To detect the loss of intestinal barrier function in *Drosophila*, following TBI, by the presence of a non-absorbable blue food dye outside of the digestive tract, after feeding. Methods: A “high-impact trauma” (HIT) device was built, which used a spring-based mechanism to propel flies against the wall of a vial, causing mechanical damage to the brain. An antibody to cleaved-Caspase-3 was used as a general apoptotic marker in whole *Drosophila* brains. The immune response was assessed by quantifying Anti-Microbial Peptides (AMP) gene expression, using qRT-PCR. Loss of intestinal barrier function was detected by the presence of a non-absorbable blue food dye (FD&C blue dye no. 1) outside of the digestive tract after feeding. Results: Increased apoptosis was detected in *Drosophila* brains subjected to TBI, by measuring cleaved caspase activity. TBI flies showed an enhanced innate immune response as measured by increased gene expression of the antimicrobial peptide, Diptericin B. More flies with TBI had the “Smurf” phenotype, compared with controls, demonstrating that impaired gut permeability is a non-neuronal effect of severe TBI. Conclusion: TBI causes distinct biochemical and genetic alterations and an improved understanding of these secondary sub-cellular mechanisms of TBI is a vital prerequisite to developing effective interventions.

## **The Effect of Deletion of the SPAG17 Gene on Fibrotic Gene Expression**

*Eric Liberczuk, Mills E. Godwin High School*

Systemic sclerosis (SSc) is a complex and clinically heterogeneous disease characterized by synchronous fibrosis that simultaneously affects multiple organs. Very little is known about the regulation of genes that cause fibrosis. Recently, it has been shown that loss of Spag17 gene results in increased collagen deposition and subsequent skin fibrosis. The purpose of this research project was to determine whether or not the Spag17 gene influences fibrosis by altering the expression of two fibrotic genes, including Col1a1 and Mmp13. It was hypothesized that loss of Spag17 induces skin fibrosis by upregulation of the expression of these fibrotic genes. Levels of expression of Col1a1 and Mmp13 were measured by qRT-PCR in fibroblasts collected from two independent variables (IV) wild-type (control) and Spag17 knockout mouse (KO) skin. Results showed higher levels of expression for both Col1a1 and Mmp13 genes in samples collected from Spag17 knockout mice. Although, results were not statistically significant due to high variation between the samples, the trend showed by the results, suggested that loss of Spag17 may promote an increase in the expression of fibrotic genes and consequent collagen deposition in the skin. This research brings to light the pathologic signaling

associated with loss of function of the Spag17 gene and may help the discovery of novel strategies to treat patients suffering from fibrotic disorders.

### **The Effect of Moisture Prevention Products on the Hydration Level of Skin after Rock Climbing**

*Michael Mann, Clover Hill High School*

### **The Effect of Brazilian Pepper Tree Extract on Bacteria**

*Kelly Melnick, Arlington Career Center*

The project tested the effect of Brazilian Pepper Tree extract on Escherichia coli bacteria. This project was chosen because of the rapidly occurring problem of bacteria becoming immune to antibiotics and the overuse of these over-the-counter drugs. The hypothesis was that the Brazilian Pepper Tree extract will have a less effective outcome than the standard antibiotics because standard antibiotics are tested and created specifically to kill bacteria. In the experiment, 70% rubbing alcohol, Brazilian pepper tree extract, and penicillin were all tested against E. coli strains to determine the effectiveness of the Brazilian Pepper Tree extract. Each petri dish was swabbed with bacteria and divided up into 4 parts and each product was put into a separate quadrant including a control. The dishes were then incubated for a 5-day period and the number of bacterial colonies was calculated. The hypothesis was disproved. The average number of bacterial colonies for Brazilian Pepper tree Extract was .07 colonies as shown in graph 1. Rubbing alcohol had a .21 average and Penicillin had a .85 average. When no products were used the average was .28 colonies. The hypothesis was rejected in this project because the average for the Brazilian Pepper tree extract received the lowest average for the number of bacterial colonies found in that particular section. This may be because the effect the extract had on the bacteria, but many of the plates never grew any bacteria so it could have been a random piece of data.

### **The Effect of Various Companies' Bottled Water on the Materialization of Microplastics**

*Carter Morris, Mills E. Godwin High School*

The purpose of this experiment was to determine the effects of various bottled water brands on the materialization of microplastics. As more products are being manufactured using plastics or being packaged with plastics, microplastics are becoming a major health concern, contaminating our food and water. To measure microplastic materialization, the water from each bottle was poured into an individual beaker and Nile Red (NR) was dissolved in the water. The solution was then photographed under a 480 nm light using an orange filter. The number of microplastics in each bottle of each brand were counted and recorded after the high-resolution pictures of each trial were analyzed. It was hypothesized that the Dasani and Smartwater bottles would equally show the least materialization of microplastics, while Nestle and Aquafina would both equally show higher levels of materialization of microplastics. The Dasani brand, on average, had the lowest number of microplastics observed per individual bottle, followed by Aquafina, Smartwater, and then Deer Park. A t-test was performed on the data and revealed that the data was significant for Deer Park versus Dasani, Dasani versus Aquafina, and Dasani versus Smartwater, however not significant for Deer Park versus Aquafina, Deer

Park versus Smartwater, and Aquafina versus Smartwater. The results did not support the research hypothesis. It is believed that the results are due to variation in water purifying and bottle manufacturing across the four brands tested. This research could lead to future studies that investigate the effects of prolonged storage on the materialization and abundance of microplastics in older bottles.

### **The Relationship between the FTO SNP rs9939609 and Food Satisfaction in Men and Women**

*Julia Moschella, Southwest Virginia Governor's School*

### **The Effect of pH on the Solubility of Ibuprofen**

*Samuel Muzinski, Arlington Career Center*

The experiment conducted was the effect of acidity on the solubility of ibuprofen. People take ibuprofen in hopes that it will relieve their pain quickly. The pH of the stomach can vary depending on how full it is. The purpose of this experiment is to find out the best pH for an ibuprofen pill to dissolve. Fifteen pills were tested in each of the seven pH levels: 2, 3, 4, 5, 6, 7, 8. The hypothesis of this experiment is if the ibuprofen is placed inside the beaker containing the aqueous solution that measures 2 pH, then it will dissolve the fastest because it is the most acidic, and the average human stomach acid measures from 1.0 to 2.5 pH. First, 6 gallons of distilled water and 1 half gallon of vinegar, or acetic acid, were prepared. 100 mL of distilled water was placed into 7 separate beakers, and vinegar was added in different amounts to reach each pH level. Baking soda was used to reach the basic pH levels. An electronic pH meter was used to record the pH levels. One ibuprofen pill was placed into each beaker at the same time, and a stopwatch was used to record how long it took for the coating to completely or mostly dissolve. The results did not support the hypothesis and demonstrated that pH does not affect the solubility of ibuprofen.

## **Medicine and Health B**

### **The Effect of Rapamycin against Ischemic Damage in Diabetic Heart cells**

*Shuvojeet Paul, Mills E. Godwin High School*

Background: Coronary artery disease (CAD) is a significant problem and a leading cause of death. Rapamycin is an immunosuppressive drug which is used to prevent organ transplant rejection in patients and blocks the "mammalian target of rapamycin" (mTOR) pathway. Previous research studies have shown that rapamycin has a significant impact on the prevention of necrosis of the heart during ischemic heart damage. My current project focused on the effect of Rapamycin in apoptosis in CAD. It compared the effect of rapamycin on the prevention of ischemic/reperfusion damage for normal cells to diabetic cells. Procedure: In both of the non-ischemic and ischemic groups, two 4-plates were treated with DMSO (100 nM), and the other two plates were treated with Rapamycin (100 nM). There were 8 levels of IV, with 4 trials for each level. The SI/RO groups were placed in the hypoxic chamber, and the other groups were simply control groups to see the effect of DMSO and rapamycin on cells without ischemic damage. TUNEL staining was done to determine the rate of apoptotic cells. The types and amounts of proteins that were expressed during the ischemia and reperfusion were also measured, and what effect

rapamycin had on them. Results: SI/RO significantly enhanced cardiac cell apoptosis under a high glucose condition. Rapamycin pretreatment significantly reduced post SI/RO cell apoptosis under all conditions. Western blot results showed that phosphorylation of AKT was not altered with Rapamycin treatment under normal as well as high glucose conditions.

### **The Effect of Perfume type on the Death Rate of Crickets**

*Elizabeth Pepper, Clover Hill High School*

### **The Effect of Rapamycin against Doxorubicin-induced Cardiotoxicity**

*Arijit Pradhan, Mills E. Godwin High School*

Doxorubicin is a chemotherapeutic drug that is commonly used on cancer patients. However, patients with cancer face a risk of suffering from heart failures. These heart failures are caused by the harmful effect of Doxorubicin on heart cells. The heart cells become non-viable and fail. Hence, I want to find a substance that can effectively be used to protect heart cells from Doxorubicin. The purpose of my study is to investigate the effects of Rapamycin, an antifungal antibiotic, against Doxorubicin-induced cardiotoxicity. Rat myoblast cells (H9C2) were treated with different concentration of Doxorubicin (0.5, 1 and 5  $\mu\text{M}$ ). Cell death was assessed by Trypan blue staining and cell apoptosis was assessed by TUNEL staining. Doxorubicin (0.5  $\mu\text{M}$ , 1  $\mu\text{M}$ , 5  $\mu\text{M}$ ) treatment for 24 and 48 hours significantly enhanced cell death as compared to the control condition in a dose dependent manner. Combination treatment with Rapamycin (100 nM) ameliorated the Doxorubicin-induced cell death by reducing cellular necrosis as well as apoptosis. Rapamycin alone did not affect cell death. The present study demonstrated that Doxorubicin-induced cardiotoxicity may be reduced with Rapamycin co-treatment, which indicates that this combination treatment can be a promising and effective therapeutic strategy for cancer patients.

### **Knockout of AEG-1 Promotes Sensitivity to Sorafenib in Human Hepatocellular Carcinoma (HCC)**

*Anusha Puri, Mills E. Godwin High School*

### **The Effect of the Circadian Rhythm on Human Blood Pressure**

*Arvind Rajesh, Mills E. Godwin High School*

The initial purpose of this experiment was to determine whether the circadian rhythm increases human blood pressure throughout three different time periods of the day. Currently, more than 70 million adults in America are diagnosed with hypertension. Many factors lead to elevated blood pressure, but the effects of many natural factors such as the circadian rhythm are not clearly known. Blood pressure readings for this study were determined using a standard digital sphygmomanometer. Twenty-five participants in the age range of 35 to 45 years were used in the experiment. Blood pressure readings were acquired for each participant at the times of 9:00 AM, 1:00 PM, and 7:00 PM on the same day. A standard digital sphygmomanometer was used to measure the participants blood pressure in a controlled environment while the participants were at rest. No control was used in the experiment since all participants underwent the same process but on 3 different occasions. The results revealed that blood pressure mainly elevates around 7:00

PM. The average blood pressure reading was higher at 9:00 AM when compared to the blood pressure readings at 1:00 PM. A sudden change in elevation then occurred which resulted in blood pressure readings peaking around 7:00 PM. A t-test was used to prove that the data was significant. All the comparison t-values and total t-value were found to be significant. The results of the experiment did not fully support the research hypothesis. Blood pressure peaked around 7:00 PM unlike the research hypothesis which stated that blood pressure would be most elevated around 9:00 AM. This relationship between circadian rhythm and blood pressure can be further studied to understand other causes of hypertension and other blood pressure related issues.

### **The Effect of FD drugs on Inhibition of Cholangiocarcinoma Cell Growth**

*Karuna Ramnani, Mills E. Godwin High School*

Intrahepatic cholangiocarcinoma (iCCA), a rare subtype of primary liver cancer, is resistant to many chemotherapeutic agents. Its overall prognosis is dismal because iCCA patients are usually diagnosed in advanced stages. This study investigates six novel organic compounds (FD-223, FD-254, FD-268, FD-269, FD-271, and FD-274) targeting the phosphatidylinositol-3-kinase (PI3K)/Akt signaling pathway, which plays an important role in cell cycle regulation and is activated in iCCA. TDE cell lines, a rat iCCA cell line, were treated with these six compounds at concentrations of 2.5, 5, 10, 25, 50, 100, 250, 500, 1000, and 5000 nM. The control treatment was pure dimethyl sulfoxide (DMSO). Dojindo's Cell Counting Kit-8 (CCK-8), a functional antagonist assay, measured the post-treatment absorbance of cell line samples, from which percentage of surviving cells after drug treatment was calculated. The half-maximal inhibitory concentration (IC<sub>50</sub>) of the drugs was determined from dose-response curves generated by GraphPad Prism software. The research hypothesis states that FD-268, FD-271, and FD-274 would have the lowest IC<sub>50</sub>. While all drugs showed significant tumoricidal activity, FD-268 and FD-271 had the lowest IC<sub>50</sub>, and therefore the greatest potency. The inferential statistics test (two-way ANOVA with replication) showed that the type of drug and its concentration individually have significant effects on the percentage of cells surviving drug exposure. The promising results of this study can be used to investigate the mechanism of action of the drugs and determine safe dosage in humans.

### **The Effect of Daily Situations on Blood Pressure**

*Ardenne Sklavos, Mills E. Godwin High School*

The purpose of this experiment was to find the effect of daily scenarios on students' blood pressure. Recently blood pressure has been on the rise in many first world countries. Students' blood pressure was taken before school, before a quiz, during lunch, and after school. Blood pressure was measured in mmHg that rated as normal, elevated, and high blood pressure. It was hypothesized that blood pressure tested before a quiz would be higher than at other times. The results revealed that blood pressure tested before a quiz was higher on average than at other times of the day. A chi-square test was done on the data and it revealed that the results were significant for all data tested. The results did support the research hypothesis. It is believed that the results are due to the fact that the quiz puts a higher level of stress on students causing their blood pressure to rise. This research could lead to further studies that investigate exactly how much this could affect

students once they reach adulthood and if the affected students might be at a higher risk for heart disease.

### **The Effect of Time-restricted Eating on *Drosophila melanogaster* Longevity**

*Marianne Tan, Mills E. Godwin High School*

The purpose of the experiment was to find the effect of different time-restricted diets on *Drosophila melanogaster* longevity. Recently, the risk of metabolic diseases has increased drastically in the United States. A source of these diseases is the disruption of the natural human feeding/fasting cycle. Current medical treatments include a time-restricted eating (TRE) diet, limiting daily feeding periods rather than calories or specific nutrients. The experiment tested that if the TRE diet is applied, then it may increase longevity of the model organism, *Drosophila melanogaster*. Newborn *Drosophila melanogaster* were tested on three time-restricted diets: a TRE diet (8 hours feeding period), a control diet (12 hours feeding period), and a diet mimicking one of an average American adult (16 hour feeding period). The daily diets were applied over the course of the flies' lifespans, about six weeks. The results revealed that flies on the TRE diet had a longer lifespan than the flies on the control diet, while the flies on the human diet had a shorter lifespan than the flies on the control diet. A t-test was performed, showing that the data was significant for the previously stated comparisons. The results suggested that shorter daily exposure to food increases longevity in *Drosophila melanogaster*. Further studies may show a difference in lifespan between male and female flies, or if the TRE diet yields similar results on mammalian model organisms.

### **The Effect of Different Races on Similarity of Fingerprints**

*Reenie Tian, Mills E. Godwin High School*

The purpose of this experiment was to find the effect of race on fingerprints. More specifically, whether or not people of races geographically closer to each other would have more similar fingerprints. Fingerprints have been used for hundreds of years in criminal justice and identification as they are the most reliable and secure way of identifying individuals. Fingerprints were taken from 75 people, 25 of either East Asian, Indian, or Caucasian descent, using a black ink pad. Fingerprints are categorized as one of the three types of fingerprints (arch, loop, whorl). There was no control present as there is no "normal" race to use as a control. It was hypothesized that a trend would be present within East Asians' and Indians' fingerprints because they are geographically closer to each other than Caucasians. The results revealed that there was a trend between the fingerprints. A chi-square test was done on the data, and it revealed the data to be statistically significant. The results did not statistically support the research hypothesis. The most similar fingerprints were, in fact, between Asians and Caucasians. It is believed that the results are due to the fact that race has an effect on fingerprints but not in terms of causing similar fingerprints. This research could lead to further studies that investigate any possible relationships between genetic diseases and fingerprints or what causes a certain kind of fingerprint.

### **The Effect of Microwaves on Defibrinated Sheep Blood**

*Evan Tuckley, Mills E. Godwin High School*



The purpose of this study was to prove the danger of electromagnetic radiation to the body, specifically blood. This experiment was performed to show how microwaves interact with and negatively affect erythrocytes. It was hypothesized that if microwave radiation occurs for forty seconds, then the blood cells will swell or rupture. This study was conducted by the stimulation of defibrinated sheep blood cells by microwaves from a standard 2.45 GHz microwave oven. Each sample was prepared on a slide and placed in the microwave oven and then microwaved for a set amount of time which varied for zero seconds, five seconds, ten seconds, and twenty seconds. After each sample was microwaved it was immediately placed under a microscope and photographed. After all the samples were photographed, they were examined. A control was set as 0 seconds of microwave radiation because that is normal for erythrocytes and the control was used as a reference. The results of the experiment were recorded after each photograph was meticulously observed and the data showed a significant change. After twenty seconds of microwave radiation thousands of erythrocytes were malformed and their color was also altered. A chi square test was performed to determine significance and provided a value that didn't reject the research hypothesis. This study achieved its goal to display the danger of electromagnetic to erythrocytes.

### **Investigating Combinations of various Chemotherapies Coupled with (NURF) knockdown on Tumor cell Cytotoxicity**

*Ashish Vaidyanathan, Mills E. Godwin High School*

This experiment determined whether the knockdown (KD) of the nucleosome-remodeling factor (NURF) would sensitize breast cancer cells to chemo-therapies. NURF is often overexpressed in cancers and thus was an ideal target. The cancer cells were inhibited of Nurf through small molecule inhibitor AU1 and genetic KD cell lines were created using shRNAs; these were then treated with the Chemotherapies doxorubicin and paclitaxel. The cells were left to incubate until colonies had formed and counted in a clonogenic survival assay. Due to prior sensitization with breast cancer, it was hypothesized that the highest level of sensitization would occur with paclitaxel. Embryonic stem cells (ESC), with and without (NURF) KD, were also tested for any increase in cytotoxicity to determine if sensitization was cancer cell specific. When NURF was inhibited molecularly in cancer cells, only doxorubicin increased its cytotoxicity by a statistically significant amount. For genetic KD, the results indicated that there was no increase in sensitization with either chemotherapy as no comparisons were significant. It was believed that doxorubicin sensitization with molecular inhibitor AU1 corresponded with an increase in DNA damage caused by (NURF) KD and doxorubicin. The possible increase in autophagic cell death could have also resulted in sensitization. Regarding the ESC, the results showed that doxorubicin did not increase cytotoxicity with (NURF) KD while paclitaxel did. When all the results are analyzed, doxorubicin with AU1 appears to be an ideal combinational therapy due its enhanced effect against cancer cells and lack of enhancement against normal cells. Future research could study ways to establish practical cancer therapies using knowledge obtained in this project involving sensitization and NURF knockdown.

### **A Computational Approach Toward Targeting Protein-ligand Interaction of Asthma**

*Devi Veeramgari, Mills E. Godwin High School*

The purpose of this experiment was to determine which asthma drug will bind and interact in the most consistent manner with the proteins of asthma. The ten drugs which were obtained from the PubChem database included: albuterol, salmeterol, beclomethasone, budesonide, theophylline, cromolyn, nedocromil, zafirlukast, montelukast, and ipratropium. Throughout the world, asthma is an extremely common human condition. This disease causes the airway to become inflamed preventing the individual from breathing normally. Asthma medicine ranges from cheap to expensive, with the most common form of delivering the medication costing \$200-\$500. As a result, it is important for individuals to know which medication will deliver the best results. It was hypothesized that if a potential molecule is identified from these simulations, then this would serve as a lead molecule to target asthmatic conditions. There were five levels of the independent variable: interleukin 4 (IL), IL5, IL9, IL13, and IL17F. Each of the ten drugs bonded to each protein using computer simulations and the binding energy was recorded in kilocalories per mole. According to the results, theophylline had the most negative binding energy overall meaning that it binds to the asthma proteins in the most consistent manner. T-tests were performed on this data, finding all the data to be statistically significant. Due to the results, the research hypothesis was supported. Further research revealed that theophylline has the most negative binding energy due to its ability to regulate the expression of inflammatory genes.

### **The Effect of Antibacterial Mouthwash on Growth of Bacteria**

*Grace Walters, Mills E. Godwin High School*

The purpose of this experiment was to find the effects of various mouthwashes on the pH level of eggshells. This project could benefit society by demonstrating either harmful or helpful effects that mouthwash can have. Eggshells were used in this experiment to mimic the results that teeth enamel would yield. It was hypothesized that if various mouthwashes or water were placed on eggshells, water would yield the highest pH level. The eggshells were broken into fragments and split into five groups of 25, measuring to about one centimeter by one centimeter. The fragments were treated with a singular milliliter Crest 3D, Arctic Luxe, Listerine, Crest ProHealth, Colgate Peroxyl, or water. Water was the control in this experiment because it has no active ingredients, which would demonstrate whether or not all liquids have an effect on eggshells. None of the data in this experiment had results that were statistically significant. There were sources of error within the experiment, which included having some of the eggshells soak for longer and having to balance out the pH level of the eggshells beforehand with the use of lemon juice and bleach.

### **Elucidating the Mechanism Underlying the Anticancer Activity of Kiwifruit**

*Jalen Wang, Mills E. Godwin High School*

Previous research has demonstrated that the kiwifruit has potent anticancer effects on prostate cancer cells indicating its potential for chemoprevention. The objective of this study was to understand the mechanism behind the anticancer activity of kiwifruit. The hypothesis is that the anticancer effect of kiwifruit involves the induction of cell cycle arrest and/or cell death in cancer cells. To test this, the LNCaP prostate cancer cell line was cultured in the presence of different concentrations of kiwifruit extract. Flow cytometry, a reliable protocol able to analyze physical and chemical characteristics of cells, together

with propidium iodide staining of DNA, was used to determine the distribution of cells in each cell cycle phase and cell death. It was found that the kiwifruit extract inhibited cell cycle progression, supported by the observation that the proportion of LNCaP cancer cells in the G0+G1 phase increased while the proportion of cancer cells in the S and G2+M phases decreased. The kiwifruit extract also induced death of LNCaP cells, indicated by an increase in propidium iodide positive cells following treatment. A dose-dependent effect of kiwifruit extract was found for both processes as higher concentrations yielded greater increases of cells in the G0+G1 phase as well as dying cells than lower concentrations. A Student's t-test was performed and confirmed statistical significance between treated groups and untreated controls. Overall, the data supported the research hypothesis that induction of cell cycle arrest and cell death are responsible for the anticancer activity of kiwifruit and strongly suggests the kiwifruit may be used to prevent prostate cancer development.

### **An Analysis of the Mosquito Vector Population in the Middle Peninsula of Virginia**

*Elizabeth Wilding, Chesapeake Bay Governor's School for Marine & Environmental Science*

### **Efficacy of Tick tubes on Reducing Tick population in a Woodland area**

*Matthew Wilson, Chesapeake Bay Governor's School for Marine & Environmental Science*

### **The Effect of various Mouthwashes on pH level**

*Hanna Wirtu, Mills E. Godwin High School*

The purpose of this experiment was to determine which of three mouthwashes was the most effective at preventing bacterial growth. This was investigated to further current knowledge about the effectivity of mouthwash ingredients. The hypothesis was that xylitol-based mouthwash would be the most effective at killing bacteria. The hypothesis was tested by using the disk diffusion method with three mouthwashes, Biotène Dry Mouth Mouthwash (primary ingredient xylitol), Tom's of Maine's Children's anticavity fluoride rinse. (primary ingredient xylitol, active ingredient sodium fluoride), and ACT Anti Cavity Fluoride Rinse (active ingredient sodium fluoride), to see how effective each mouthwash was at preventing bacterial growth. The bacterial growth around each disk was observed and categorized into one of three categories: overgrown, zone of inhibition, and no zone of inhibition. Overgrown was when the bacteria grew over the filter paper disk. Zone of inhibition was when there was a zone of inhibition. No zone of inhibition was when the disk was not overgrown, and there was not a zone of inhibition around the filter paper disk. The control for this experiment was a filter paper disk dipped in water to observe how the bacteria would react to an untreated disk. The results did not support the hypothesis. Biotène Dry Mouth Mouthwash had a mode of no zone of inhibition, ACT Anti Cavity Fluoride Rinse had a mode of zone of inhibition, Tom's of Maine's Children's anti cavity fluoride rinse had a mode of overgrown, and water had a mode of overgrown.

### **The Effect of Age-related Cytokine Expression on Proliferation of Cancer cells**

*Nathan Wu, Mills E. Godwin High School*

The purpose of this experiment was to find whether the age of male Fisher 344 rat serum had different concentrations of cytokines. Research using PC-3 and MCF-7 cancer cells indicated that there was a correlation between transfusion of younger and older serums and the proliferation of cancer cells. It is highly likely that this proliferation of cancer cells was due to cytokine present in serum interacting with cancer cells. It was hypothesized that the cytokines EPO, GM-CSF, GRO/KC, and IL will have the highest differences between the two age groups of three months and two years. The primary independent variable was the age of the male Fisher 344 rat serum was extracted from, and the secondary independent variable was the different cytokines screened for by an assay which included: MCP-1, EPO, GM-CSF, GRO/KC, IFN-gamma, IL cytokines, MIP-1 alpha, M-CSF, MIP 3-alpha, Rantes, TNF-alpha, and VEGF measured in (pg/mL). This concentration was measured through a multiplex bead-based assay. There was no control group because there is no "control age" group of humans to which this experiment is applicable. A traditional procedure was used with regards to serum extracting; animals were sacrificed through cardiac puncture, and the blood from the animal was centrifuged. The multiplex bead assay followed the manufacturer's instructions. Cytokine concentration values were quantified interpreted by Bio-Plex Manager Software data was significant for the cytokine: EPO, GRO/KC, IL-1 beta, IL-4, IL-5, IL-10, IL-17, IL-18, MIP-1 alpha, and MIP-3 alpha. Data found, when compared to MCF-7 and PC-3 cancer cell proliferation experimentation, was supported by several studies, indicating a correlation between IL cytokines and proliferation of (breast) cancer cells. There were few sources of error, but experimentation could be continued with further trials and experimentation with isolated cytokine medium added to cancer cell cultures.

### **The Effect of Various Antifungal Creams on the Production of Carbon dioxide by *Saccharomyces cerevisiae***

*Joanne Yang, Mills E. Godwin High School*

The purpose of this experiment was to find the effects of various antifungal creams on the production of carbon dioxide by *Saccharomyces cerevisiae*, also known as brewer's yeast. Infections such as athlete's foot and ringworm have affected many people, so this experiment tested which of the three most popular antifungal creams, terbinafine, tolnaftate, or clotrimazole used was the most effective. A hypothesis was formulated that if clotrimazole antifungal cream was diluted and experimented on the yeast, then it would produce the least amount of carbon dioxide. The anti-fungal creams, water, and sugar were added to four grams of *Saccharomyces cerevisiae* and then waited for ten minutes for carbon dioxide to be collected. For the control, no antifungal cream was added to the squeeze bottles. The results showed that clotrimazole produced the least amount of carbon dioxide. A t-test was performed and the anti-fungal creams vs. the control (water) was significant, but the antifungal creams compared to each other were all not significant. Due to these results, the research hypothesis was not supported. The reason for the results could be due to the fact that since all the antifungal creams are topical, they perform the same action of destroying ergosterol. If this experiment was to be extended, other concentrations of the three antifungal creams could be used. The length of time could also be changed in order to find the rate of efficiency.

## **The Effect of Different Methods of Extraction of 6-shogaol from Ginger (*Zingiber officinale*) on the Protection of Dopaminergic Neurons in Parkinson Disease**

*Edward Zhang, Mills E. Godwin High School*

Parkinson's disease (PD) is a neurodegenerative disorder which attacks 10 million people's midbrain dopaminergic neurons and reduces patients' motor skills. *Zingiber officinale*, commonly known as ginger, has been used in Asia to prevent PD through different methods of cooking. The purpose of this experiment was to examine different methods of extracting 6-shogaol, a pungent compound found in ginger, and the extract's protection of dopaminergic neurons, measured through absorbance of nitric oxide (NO), a biomarker of PD. Ginger was cut, dried, and ground into powder, which were then extracted with either 95% ethanol, water, or hexane, the three independent variable levels. After high performance liquid chromatography and mass spectrometry analysis, the extracts were given to neurons, which were then treated with 1-methyl-4-phenylpyridinium, or MPP+ (a neurotoxin used to induce parkinsonism in cells), and afterwards tested for their absorbance of NO. The controls were the cells given only MPP+, and it was hypothesized that the 95% ethanol extract was going to protect the cells the best. The data showed that all levels protected the cells to different degrees and the research hypothesis was supported. After a t-test analysis, the data showed that the hexane and ethanol levels were significant to the MPP+ level, so the null hypothesis was rejected for those two levels. On the other hand, the water level was not significant, and therefore the null hypothesis was rejected for that level. The results of the experiment could be because 6-shogaol is believed to inhibit the signaling pathways that MPP+ activates to cause inflammation in the brain which can help explain the results. Future research could be conducted on 6-shogaol's utility in treating or preventing PD.

## **Microbiology and Cell Biology A**

### **Utilizing CRISPR/Cas9 to Investigate Connexin43 under Hypoxic Stress**

*Lauren Frampton, Roanoke Valley Governor's School for Science & Technology*

NGap junctions, composed of connexin proteins, facilitate intercellular communication. Altered expression and localization of connexin43 (Cx43) in response to cellular stressors results in disrupted intercellular communication and has been implicated in disease. GJA1, the gene encoding Cx43, undergoes internal translation to produce several small protein isoforms. The GJA1-20k isoform has been speculated to promote Cx43 trafficking to the cell border, and reduction of GJA1-20k expression correlates with reduced gap junction formation during hypoxic stress. The objective was to utilize CRISPR/Cas9 to generate cells expressing connexin43-green fluorescent protein (Cx43-GFP) under control of the endogenous GJA1 promoter to visualize Cx43 under hypoxic stress, and to compare with traditional immunofluorescence detection of Cx43. Immunofluorescence labeling was performed to identify changes in Cx43 localization in mammary epithelial cells expressing lacZ (NMuMG lacZ), as a control, and GJA1-20k (NMuMG 20k), and in lung epithelial tumor A549 cells. To visualize Cx43 in living cells, guide RNAs (gRNA) were designed to target Cas9 nuclease to the 3' end of the coding region of the GJA1 gene. Plasmids encoding the CRISPR/Cas9 enzyme, gRNAs, and a donor GFP-puromycin sequence were transfected into A549 cells. Flow cytometry and puromycin were used to screen for cells incorporating the GFP-puromycin DNA under control of the

GJA1 promoter. Quantitative analysis of Cx43 following 0, 24, and 48 hours of hypoxic stress revealed increased accumulation of Cx43 at the cell border. These results suggest expression of GJA1-20k promotes trafficking of Cx43 and increases gap junction formation.

**The Effect of Native Species of Countries with High Prevalence of *Helicobacter pylori* Infection in Adults on the Inhibition of *Lactococcus lactis***

*Adhvikaa Ambikapathi, Maggie L. Walker Governor's School for Government & International Studies*

**The Effect of Sugar Substitutes on Yeast Fermentation**

*Kayla Anderson, Washington-Lee High School*

**The Effect of Different Types of Sugar on the Zone of Inhibition of *Escherichia coli***

*Fardeen Bablu, Washington-Lee High School*

**The Evaluation of Swarm Intelligence in *Physarum polycephalum* to Expand Adaptive Network Applications**

*Ellianna Bailey, Chesapeake Bay Governor's School for Marine & Environmental Science*

The use of biological principles such as emergence and swarm intelligence can expand the horizons of autonomous studies and other adaptive networks. For example, bio-networking architecture, a biologically inspired approach to the design of scalable, adaptive, and survivable/available network applications, considers the concept of emergence by implementing network applications as a group of distributed and autonomous objects called cyber-entities (CE). This shows the application of biological principles into technological science. A maze with three pathways of three different lengths leading to oat flakes was given to *Physarum polycephalum*, a species of slime mold, to study its ability to solve mazes and simulate efficient networks. Against expectation of the null hypothesis, the *P. polycephalum* took the shortest path more than all other available paths. A chi-square analysis showed that the slime molds were significantly more likely ( $p < .01$ ) to follow the shortest path than other two paths. Once the *P. polycephalum* chose a pathway, another maze with the shortest path blocked was given to the *P. polycephalum* to study its ability to adapt. The results were analyzed again with a chi-square test resulting in the p-value of 0.025347. The experiment was conducted to test the reproducibility of the results that Toshiyuki Nakagaki recorded when testing the *Physarum's* ability to solve mazes and Atsushi Tero's results of finding the most cost-efficient pathway, which it did reproduce. The data validates that simple units can complete a complex task with no directives from a centralized center highlighting the benefits of complex adaptive systems when creating autonomous systems, because they can adapt to new situations, whereas a centralized system can only respond to situations it was programmed for. Without the need to direct the units individually, there is no need to manage a central command system thus allowing them to run autonomously.

**The Effect of Yeast Expiration Dates on Height of Rising Bread**

*Kaelynn Bemis, Clover Hill High School*

**The Effect of Number of Maze Pathways on *Physarum polycephalum*'s Maze Solving Ability**

*Joshua Bowling, Clover Hill High School*

**The Effect of Acetylsalicylic Acid on *Escherichia coli* Colonies**

*Victoria Bui, Mills E. Godwin High School*

The study was conducted to discover if acetylsalicylic acid, the active ingredient in aspirin (ASA), has any effects on the colonies of *Escherichia coli*, which populate the gastrointestinal tract. Despite aspirin being used for anti-inflammatory purposes, it is known to cause gastrointestinal complications, such as bleeding, ulcers, and dyspepsia. From this, the theory was drawn that the ASA could affect the gut bacteria particularly *E. coli*. The bacteria assist with digestion and vitamin absorption, so there is the possibility that ASA could negatively impact these processes and make the medication less useful. The hypothesis was that if the concentration of acetylsalicylic acid increases, then fewer colonies of *E. coli* will grow. The control was no acetylsalicylic acid, since that is typical in the bacterial environment. For the procedure, one hundred petri dishes, pre-plated with agar, were poured with solutions of different concentrations (0, 0.625, 1.25, and 1.875 g/250 mL, with 25 plates per concentration) and diluted *E. coli*. They were incubated for two days and manually counted. The mean number of colonies was 14.8 for the control, 10.32 for 0.625 g/250 mL, 25.28 for 1.250 g/250 mL, and 0.04 for 1.875 g/250 ml. The majority of the t-tests performed showed the data to be insignificant. The results may be explained by confounding variables, such as contamination of plates or miscounting of colonies. Possible future experiments include testing different analgesic drugs on intestinal bacteria.

**The Effect of Various Homeopathic Substances on the Zone of Inhibition of *Propionibacterium acne***

*Lauren Chase, Central Virginia Governor's School for Science & Technology*

The purpose of this experiment was to test the effect of various homeopathic substances on the zone of inhibition of *Propionibacterium acne* (*P. acne*) when compared to salicylic acid's effect on *P. acne* zones of inhibition. Homeopathic substances included pure tea tree oil, organic apple cider vinegar, witch hazel, and manuka honey. A 10% tea tree oil/jojoba oil solution was also tested to mimic a tea tree oil cleanser. Both pure salicylic acid and a 10% salicylic acid/glycerol solution were tested as a comparison. During this experiment, aseptic technique was used when handling materials and microbes. In order to collect data, zones were measured with a ruler in millimeters. Data analysis was tested against an alpha value of .05. A one-way ANOVA test showed that the collected data had significance with a p-value of 1.10359E-39, and after performing a Tukey Test, it was found that there was significance between the pure salicylic acid, manuka honey, and the pure tea tree oil. Tea tree oil created the largest zone of inhibition, thus, the hypothesis that manuka honey would create the largest zone of inhibition was not supported. The results of this experiment suggest that tea tree oil may be a viable substitute for salicylic acid in acne treatments.

## **Sweetener Effects on Fermentation Rates in Kombucha**

*Solace Church, Southwest Virginia Governor's School*

Kombucha has been consumed for thousands of years. There are many health benefits that are tied with drinking this fermented tea and homemade kombucha has been gaining popularity in the United States. As most people are still learning about kombucha, they would greatly benefit from knowing which sweeteners are optimal in the process of kombucha production. Knowledge of the link between fermentation rate and sweetener type could lead to more efficient kombucha production. This project evaluated how the type of sweetener used in kombucha production affects the pH levels. Twenty-five batches of kombucha were prepared; there were five types (turbinado sugar, brown sugar, honey, stevia, and agave) of sweeteners with five batches per sweetener. The batches were all left in the same room for two weeks. On the first two days and last three days, each batch was tested with a digital pH meter; means for each day were recorded and analyzed. The results were only significantly different on the first two days. On the first day, brown sugar (3.34+/-0.02) was significantly more basic ( $p=0.0205$ ) than stevia and turbinado sugar (3.20+/-0.0). All of the kombucha batches had a pH within the desired range of 2.5-3.5 on the first day. On the second day, turbinado sugar, brown sugar, and honey all were more basic than this range. Agave and stevia, however, stayed in the range for the entirety of the experiment. Turbinado sugar (3.76+/-0.07) was significantly more basic than ( $p=0.0186$ ) stevia (3.46+/-0.09) and ( $p=0.0112$ ) agave (3.44+/-0.02). Honey (3.70+/-0.06) was also significantly ( $p=0.0494$ ) more basic than agave. Looking at these statistics, it seems as though agave and stevia are more efficient in the production of kombucha than brown sugar, honey, and turbinado sugar.

## **The Effects of Treatments on Bacterial Infection**

*Amya Clark, Portsmouth STEM @ I.C. Norcom High School*

The purpose of this experiment was to find a cure for bacterial infections with antibiotics so people can get quick treatment for infections. I wanted to answer the question: "How could we utilize microorganisms to fight infections?" My hypothesis for this project is, if antibiotics are applied to various species of bacteria, then (penicillin) will kill the most. A kit was used from Carolina Biological that used *Escherichia coli* and *Micrococcus luteus* as the infections that would be fought by the fungus, *Penicillium notatum*, and the bacterium, *Streptomyces sp.* Because of time constraints, this experiment did not produce viable results. So, I did it a second time using different kinds of bacteria from locations around the school, and treating with *P. notatum*, and *Streptomyces sp.* again. This version of the experiment was much more productive: it started to cause the infectious bacteria to die off. However, counting colonies of bacteria were very difficult, so I do not think I can say my hypothesis was proven through a statistical analysis of the data.

## **The Effect of Different pH levels on the Number of Bacteria Measured on Pork Meat**

*Lucas Codispoti, Washington-Lee High School*

The objective of this project was to determine whether different pH levels of pork meat would allow bacterial growth. The pH of pork meat is crucial for it to be sanitary for human consumption. It should always be at about 5.6-5.7, making it slightly acidic. Pork is eaten widely across the globe and this experiment tests solutions of different pH and their effects



to stop bacterial growth or denature the flesh. The research question was: What is the effect of different pH's on the number of bacteria measured on pork meat? Five solutions were tested: Hydrochloric Acid, Vinegar, Water, Baking Soda, and Lye. These solutions have varying pH's between 1.1 and 13.1. It was concluded that when solutions with higher level pH were added there was less bacterial growth.

### **The Effect of Different Cleaning Disinfectants on the Bacteria *E.coli***

*Charleston Couture and Sofia Warfield, Washington-Lee High School*

The purpose of this experiment was to study the effect of three different disinfectants (bleach, Method hand soap, and a natural homemade soap solution made of white vinegar, lemon juice, and tea tree oil) on *E. coli*, a common household bacteria. The hypothesis was that if bleach was used, it would kill more bacteria than the other products. The hypothesis was supported by the data collected. Bleach had the largest zone of inhibition out of the three independent variables with an average width of 4.0 cm. The natural soap solution had the second largest zone of inhibition with an average of 2.6 cm. The Method hand soap had the smallest zone of inhibition of the three independent variables with an average of 2.4 cm. The control group (no disinfectants) had no zone of inhibition with an average of 0 cm. An ANOVA test was done to determine if there was a statistically significant difference among the means. The calculated p-value was  $3.87 \times 10^{-25}$ , which is less than the value 0.05, confirming that the data was significant. The null hypothesis was: if different disinfectants were applied to *E. coli*, then no sign of disinfection would be seen. Due to the significant data, the null hypothesis was able to be completely rejected. The results suggested that all three disinfectants (bleach, Method hand soap, and the natural soap solution) could effectively kill the strains of *E. coli*. Three 2-sample t-tests were done, and the results suggested that the Method hand soap and the natural soap solution were not significantly different from one another, but they were each significantly different when compared to bleach.

### **The Effect of Calcium carbonate and Calcium sulfate on the Growth of *P. pannorum***

*Bethany David, Central Virginia Governor's School for Science & Technology*

The purpose of this study was to determine if a relationship between cave composition and the growth of *Pseudogymnoascus destructans* exists. To test the percent coverage of *Pseudogymnoascus pannorum* after being grown in different solutions, the fungus was cultured in test tubes and placed in an incubator for one week at 25°C. Then, 0.1 ml of a 5% solution was added to the test tubes and allowed to grow for three days and the percent coverage of the petri dishes was recorded. An ANOVA on percent coverage produced a p-value of  $6.7E-3$  ( $\alpha=.05$ ), indicating the data were significant. To find where the significant difference was, a Tukey Test was conducted, which demonstrated a difference of 41.1 between  $\text{CaCO}_3$  and  $\text{CaSO}_4$ , and a difference of 52.9 between  $\text{CaSO}_4$  and the control group. Since the D-min was 39.3, this showed that the group with  $\text{CaSO}_4$  was the group with the statistically significant difference. The research hypothesis, "If I grow *Pseudogymnoascus pannorum* with calcium carbonate or calcium sulfate in the test tube broth, then the *P. pannorum* grown in calcium carbonate will grow more than the *P. pannorum* with calcium sulfate," was supported, because the petri dishes with  $\text{CaCO}_3$  had a higher percent coverage than the group grown with  $\text{CaSO}_4$ . In conclusion, common

chemicals found in the geology of caves can affect fungus growth, but more research should be conducted to assert the findings of this study.

### **Resveratrol mediated Epstein-Barr virus lytic induction: A novel therapeutic approach for EBV-positive lymphomas**

*Logan Dunkenberger, Roanoke Valley Governor's School for Science & Technology*  
Epstein-Barr virus (EBV) is a prevalent herpesvirus which is strongly implicated in the development of numerous cancers. Central to tumor progression, hypoxia has also been demonstrated to play a significant role in the EBV life cycle by inducing a switch from latent to lytic replication. Using an in vitro hypoxia model, the present study showed that HIF-1 $\alpha$ -induced EBV lytic reactivation led to a significant increase in VEGF-A expression compared to EBV- lymphoma cells. This supports a novel role for lytic infection in promoting vascular instability and tumor growth. Targeting the virus using the antiviral drug acyclovir (ACV) may offer an alternative therapeutic strategy for EBV+ cancers. While data presented here indicate ACV is ineffective in the context of low-level viral reactivation, high-level induction of lytic gene expression using sodium butyrate (SB) and phorbol 12-myristate 13-acetate (PMA) was achieved in EBV+ lymphoma cells, rendering them susceptible to ACV. However, lytic reactivation also appeared to increase the metastatic potential of lymphoma cells as seen by the up-regulation of LMP1, an EBV oncogene, and VEGF-A, a potent inducer of vascular permeability. Introduction of the phenolic compound resveratrol inhibited LMP1 and VEGF-A expression, demonstrating its potential to reduce the risk of complications associated with lytic EBV infections. Taken together, these findings support novel roles for EBV reactivation in lymphoma progression and suggest that therapeutically targeting this form of infection may offer an effective alternative to chemotherapy, in the treatment of EBV+ disorders.

### **The Effect of Varying Colors of Light on the Growth Rate of *Micrococcus luteus***

*Emiko Ebreneyin, Central Virginia Governor's School for Science & Technology*

### **The Effect of Black Cumin, Turmeric and Ginger Oils on Colony Forming Units of *E. coli***

*Jacob Foster and Spencer Lewis, Washington-Lee High School*

The purpose of this experiment was to test the antibacterial effects of Black Cumin, Turmeric and Ginger oils on DH5-Alpha *E. Coli*. This could be beneficial due to bacteria constantly increasing their resistance to modern medicines. The hypothesis of this experiment was if Black Cumin oil was applied to growing *E. Coli* then the number of colonies forming units (CFUs) would decrease. We chose this hypothesis because of other studies with successful data of Black Cumin having antibacterial properties. We tested this by diluting the oils and bacterial stock down to the -5 and -6 dilutions. The solutions were then plated on agar plates using pipettes. We incubated the agar plates for 24 hours and then counted the colonies of *E. Coli*. The experiment showed that in all three dilution sets (Cumin, Turmeric and Ginger) the spices limited the growth of the *E. coli*. Based on the data from the independent variables and comparing it to the data of the control there were significant decreases in colonies. Black Cumin had 4.6 CFUs average at the -5 and Ginger had 6.1 CFUs at the -5. This being compared to the 57 CFUs of the -5 for the control was a massive change. Turmeric's average was 21.5 CFUs

which although larger than Black Cumin, still decreased the number of colonies. The -6 dilutions were just as effective. Black Cumin averaged 0.4, Ginger averaged 0.3 CFUs and Turmeric averaged 4.6 CFUs. The control averaged 8 CFUs for the -6 dilution and a larger colony count than all three test articles. This shows that the spices were extremely effective at limiting bacterial growth.

### **The Effect of Various Solutions on H<sub>2</sub>O<sub>2</sub> Breakdown in Liver Cells**

*Jefin Jose, Mills E. Godwin High School*

The purpose of this study was to determine how discrete vegetative extracts would affect the normal radical-scavenging ability (RSA) of swine liver. Decocted extracts were made using avocado (*Persea americana*), ginger (*Zingiber officinale*), and orange (*Citrus X sinensis*), as they naturally provide antioxidant properties to humans. It was hypothesized that the antioxidants in avocados would yield the greatest RSA. Tests were performed to observe the re-stabilization time of a liver solution pretreated with the three extracts in which shorter re-stabilization periods suggested a greater RSA. It was found that liver solutions pretreated with avocado extract had a significantly shorter re-stabilization period than the control group ( $\bar{x}=7.1s$  vs.  $11.1s$ ) when 5 ml of H<sub>2</sub>O<sub>2</sub> was added. A two-sample t-test revealed that there was a significant difference between these two levels ( $p=0.034$ ) due to the antioxidative effects of avocado extract. The results suggest that for optimal antioxidant defense against toxic reactive oxygen species (ROS), avocados should be consumed to relieve the oxidative stress induced by various hepatic and physiological conditions. Hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>) acts as a free-radical which induces the degradation of cell walls and mitochondria deterioration, leading to cell death. Significant research on oxidative stress has concluded that ROS play a role in non-alcoholic fatty liver disease, chronic obstructive pulmonary disease, atherosclerosis, and neurodegenerative diseases. Extended research on free radicals could lead to improved liver health and decreased aging effects.

### **The Inhibition of Methane-producing Bacteria using Novel Compound: $\beta$ -carboline**

*David Kang, John Randolph Tucker High School*

Methane, a very harmful greenhouse gas, is around 84 times more potent than carbon dioxide, making the emission of this gas in the atmosphere a big threat to rising global temperature. One of the biggest producers of methane is livestock; more specifically, cattle. The methane in cattle is produced by methanogens, which are a group of archaea that produce methane as an end product of their anaerobic respiration.  $\beta$ -carboline is an alkaloid that possesses diverse biological properties, including antitumor, antiparasitic, and antimicrobial activities; however, its complete pharmacological effects are currently unknown. The aim of this study was to analyze the effect of 1-Acetyl- $\beta$ -carboline (AbC) on methanogens using chemical synthesis. It is hypothesized that *M. smithii* and *M. arboriphilus* if treated with  $\beta$ -carboline will result in the inhibition of the methanogens. Also, the cell viability and toxicity of  $\beta$ -carboline will be investigated. The results showed that 1-Acetyl- $\beta$ -carboline inhibited the growth of *M. smithii* and *M. arboriphilus*, higher concentrations of AbC exhibited greater inhibition of methane production, deoxycholic acid (DCA) added to AbC decreased the relative growth of both methanogens dramatically, and the toxicity of AbC concentrations showed little to no increase in cell

death compared with no AbC addition. 1-Acetyl- $\beta$ -carboline had proven to inhibit the growth of *M. smithii* and *M. arboriphilus*, which shows  $\beta$ -carboline's potential in becoming a drug to inhibit methanogens in the cattle rumen, a potential and novel solution of slowing down methane emission into the atmosphere. Further studies could be conducted by performing an in vivo study.

### **The Effect of Different Natural Organic Compounds on the Growth of *Staphylococcus aureus***

*Abhishek Kulkarni, Mills E. Godwin High School*

This project, in its present form, studied the growth response of *Staphylococcus aureus* when exposed to natural organic compounds. With bacterium, such as *S. aureus*, contaminating commercial foods, gaining resistance to synthetic drugs, as well as producing harmful, resilient enterotoxins, the need to suppress and kill these bacteria has risen dramatically. A research hypothesis was formulated that stated that if *Staphylococcus aureus* was exposed to a 30% (150mg) concentration of Citric acid, then it would have the lowest optical density. Growth of the bacteria was measured with optical density using a spectrophotometer. Citric acid, Oregano Oil, and Olive Leaf Extract were made into concentrations based off of previous researchers, and pre-grown gram-positive *Staphylococcus aureus* bacteria were used as test organisms. After creating concentrations for each of the compounds, the bacteria were incubated in their respective solution, and the optical density was measured and compared. In general, there was statistical significance within data sets, as well as low standard deviations, denoting that the data for each of the independent variables were close together. Seventy-five mg of Citric acid resulted in the lowest overall OD level, suggesting that citric acid, along with a 3% concentration, inhibited growth the most. The data from this project are extremely important as they support the results shown from the literature, due to the dissociation of Citric acid molecules, and also provide a way that commercial companies can reduce possible contamination through natural processes that could be easily incorporated into food.

### **The Impact of *Escherichia coli* Age on Antibiotic Effects**

*Graysen Adams, Central Virginia Governor's School for Science & Technology*

The purpose of this experiment was to see if the age of bacteria (*E. coli*) affected its resistance to ampicillin and recovery growth. The experiment was conducted by using jars to culture the bacteria and then spread plates with an ampicillin disk in the center to create eight trials. Data were collected by measuring zone of inhibition after 24 and 72 hours. The zone of inhibition for resistance had the smallest mean (23 mm) with the middle trial; the regrowth had the smallest mean (17.4) with the oldest trial. The data were analyzed with a single factor ANOVA, with an alpha of .05, and then followed by a Post-hoc Tukey Test. The zone of inhibition had a p-value of 4.68E-3 and the Tukey Test showed a significance between the two-day trial with the four-day and eight-day trials. The null hypothesis was rejected, but the research hypothesis was not supported because the means were not the smallest on the oldest trial. The regrowth had a p-value of 9E-11 and the Tukey Test showed significance between the two-day trial with the eight-day and four-day trial. There was also significance between the four-day trial and the eight-day trial. The null hypothesis was rejected, and the research hypothesis was

supported because the mean for regrowth was smallest on the oldest trial. This project demonstrated that when given more time to establish, *E. coli* can recover best from antibiotic use.

### **The Effect of the Type of Solvent on the Mass of Fat Lost**

*Gaston Finger, Washington-Lee High School*

The purpose of this experiment was to find out how much mass pork fat would lose when placed in various chemicals. To perform this experiment, groups of pork fat were placed in various chemicals for 30 minutes. They were then taken out and dried, then their mass was measured and compared to the initial mass of 20 grams. The results of this experiment were quite complicated. The hypothesis was if ethyl acetate was used, then it would make the fat lose the most mass because ethyl acetate is a stronger chemical than both cyclohexane and propionic acid. This was not entirely false. Ethyl acetate did have the highest mean, but its error bars overlapped with the error bars of cyclohexane. The null hypothesis, however, was rejected for only some error bars overlapped, meaning the independent variable had a significant effect on the dependent variable. It was concluded that ethyl acetate had the largest mean mostly due to experimental error, for lipids are nonpolar and ethyl acetate is polar, meaning it could not dissolve a lipid, but cyclohexane is nonpolar, and its mean was very high. Propionic acid most likely did not cause the fat to lose very much mass because it was a weak chemical and is usually recognized as safe. Errors in this experiment could have been due to the varied surface areas, chemicals still in the fat when it was weighed, and using small quantities of both fat and chemicals

## **Microbiology and Cell Biology B**

### **The Effect of Different Acne Medications on *Staphylococcus epidermidis* Growth**

*Diana Kirilov, Mills E. Godwin High School*

The purpose of this experiment was to study the effect of acne medications with different active ingredients on *S. epidermidis* growth. Acne vulgaris is a condition that can affect any individual and has the ability to damage an individual's physical and psychological health. An individual's physical health deteriorates from the acne itself and from the scarring that can occur, and acne can lead to the development of psychological issues such as social anxiety and low self-esteem. This research is important because it can be applied to help treat people suffering from acne vulgaris. It was hypothesized that if different acne treatments were tested on *S. epidermidis* bacteria, then the treatment containing benzoyl peroxide would perform best. The disk diffusion method was used to test this hypothesis, with the largest zones of inhibition denoting the best acne medication. The levels of the independent variable were treatments with salicylic acid, adapalene, benzoyl peroxide, and water as the control. At the end of the 48-hour incubation period, the zones of inhibition the treatments produced were measured in millimeters. It was found that only the treatment containing salicylic acid produced results, and a t-test confirmed that they were significant when compared to every other level and the control. None of the other levels were significant when compared to the control or the other levels. This was most likely due to the fact that *P. acnes* was not used and the anaerobic conditions that the treatment containing benzoyl peroxide uses to kill *P. acnes* were not

replicated. The treatment with salicylic acid likely only produced results because of its other ingredients such as witch hazel that has known antibacterial properties.

### **Various Chelating Agents on the Concentration of Calcium oxalate in *Spinacea oleracea* (spinach)**

*Chamanthi Konidala, Mills E. Godwin High School*

In recent years, the concern over the prevalence of kidney stones in a human body has grown drastically. By recognizing kidney damage due to the passing of calcium oxalate crystals in the urinary tract, scientists are developing new techniques to prevent the formation of calcium oxalate stones before they are transported through the body. Substances known as chelating agents are one method to dissolve the calcium oxalate molecules. The purpose of the experiment is to determine whether applying various chelating agents has different effects on the concentration of calcium oxalate remaining. It was believed that if Vitamin B-12 was implemented, then it would result in a smaller concentration of calcium oxalate than the concentration resulting from EDTA. To identify the remaining concentration of calcium oxalate, a titration was performed with potassium permanganate. For the control, no chelating agent was added to the spinach solution because chelating agents are not normally used in the regular environment. Based on the data, EDTA resulted in the smallest average calcium oxalate concentration, followed by Vitamin B-12 and the control group. Based on the inferential statistics calculations performed, it was determined that there was a statistical significance for the control versus EDTA and EDTA versus Vitamin B-12. The comparison between Vitamin B-12 and the control had no statistical significance. Through additional research, it was found that EDTA has the ability to bond more than once with a single metal ion and therefore, the metal ion will have a harder time breaking away from the chelating agent. Vitamin B-12, on the other hand, is a more stable substance so it resists bonding with other metal ions.

### **The Effect of the Type of Light on the Opacity of *E. coli* Growth**

*Elizabeth Koumans, Yorktown High School*

As bacteria evolve and become resistant to common antibiotics, it is important to find other ways of eliminating them. The purpose of this experiment was to contribute to microbiology research on alternatives to antibiotics by determining what type of light was most effective at inhibiting bacterial growth. The bacteria being tested in this experiment was *Escherichia coli* (*E. coli*). Five cardboard boxes were filled with five agar plates of *E. coli* each and placed next to five different types of light. The types of light were darkness (control), white light, red light, blue light, and ultraviolet light (UV-B range). The *E. coli* was left to grow for 48 hours. Afterwards, the opacity of the *E. coli* growth was measured. The hypothesis was that ultraviolet light would inhibit the growth of *E. coli* the most. The data did not support the hypothesis but rather showed that no type of light successfully inhibited the growth of *E. coli*. This was shown by the mean opacity of *E. coli* growth for each type of light being about 50% opacity and a p-value of 0.4996 showing that there was no statistically significant variation in the data. This could be because *E. coli* is not photosynthetic bacteria, so light may not affect its growth as much as light may affect the growth of other bacteria. Future studies should make sure that the amount of light used on each agar plate of bacteria is consistent, to ensure accuracy of the data.

## **What is the Effect of Handwashing Methods on Diameter of Zone of Inhibition in Bacteria?**

*Ainsley McCabe, Washington-Lee High School*

This experiment was conducted to determine the effect of handwashing methods on the diameter of the zone of inhibition of *Escherichia coli* bacteria. The different independent variable levels were the control (water), regular soap, antibacterial soap, and Purell hand sanitizer. These hand washing agents were placed in the center of a petri dish that was covered in bacteria and then put in an incubator for two days. The zone of inhibition, or the circle within which bacteria are killed, was then measured to see which independent variable level killed the bacteria the most successfully. The hypothesis was that if the type of hand washing method is changed, then Purell hand sanitizer will have the largest zone of inhibition because bacteria have not developed resistance to the main ingredient in Purell hand sanitizer, ethyl alcohol, unlike the main ingredient in antibacterial soaps, triclosan, which bacteria can resist, by mutating. The means and standard deviations were calculated, and Purell hand sanitizer did have the highest zone of inhibition. Antibacterial soap had the next highest mean, then regular soap, and lastly water which had a mean of zero, killing no bacteria. ANOVA and t-tests were done to determine the significance of the data, and the null hypothesis was able to be rejected because the data was significant. This experiment did support the research that was done and enforced how good alcohol is at killing bacteria. Further research into antibacterial soap and regular soap would be interesting to evaluate bacterial resistance and how that can affect people's health.

## **The Effect of the Amount of Artificial Urine on Wattage Output in Microbial Fuel**

*Alexandra McDonald, Yorktown High School*

## **The Effects of Natural versus Synthetic Cleaners on the Zone of Inhibition of *Escherichia coli***

*Alyssa McGinnis, Mills E. Godwin High School*

The purpose of this experiment was to find the effects of natural versus synthetic cleaners on the zone of inhibition of *Escherichia coli*. In recent times, more people have been using all-natural cleaning products rather than chemical cleaners, but the effectiveness of these two types of products may not be the same. *Escherichia coli* was plated onto petri dishes, and wells were cut into the agar. Each well was filled with Clorox Cleaner, Lysol Cleaner, Method Cleaner, Mrs. Meyer's Cleaner, and water (control). The plates were allowed 48 hours to incubate and then the diameter of the zones of inhibition were measured. It was hypothesized that if natural cleaners were used, they would have the largest zones of inhibition. The results revealed that the Clorox cleaner had the greatest zone of inhibition which was, on average, 17.5 mm greater than the Lysol cleaner, and the two natural cleaners and the control had little to no zones of inhibition. A t-test was done on the data and it revealed that the data was not significant between Method and Mrs. Meyer's cleaner and those cleaners versus the control, but significant for all other comparisons. The results did not support the research hypothesis. It is believed that the results are due to the fact that all-natural cleaning products do not have antimicrobial properties that chemical cleaners possess. This research could lead to further studies that investigate the most effective frequency and type of cleaning on *E. coli*.

## **The Relationship between Codon Usage Bias, mRNA half-life, and the Ste13 protein**

*Claire Morton, Blacksburg High School*

The half-life of messenger RNA (mRNA) is closely regulated by cells to ensure proper levels of protein production. Recent research in bacteria and budding yeast has suggested that mRNA half-life correlates with codon usage bias: mRNAs with a high frequency of “non-optimal” codons are short-lived. In budding yeast, the short half-life of such mRNAs depends on the RNA-interacting protein, Dhh1p. Whether this extends to other organisms is unknown. This research sought to address the potential role of the Ste13 protein, the fission yeast ortholog of Dhh1p, in modulating the half-life of mRNA. To this end, the *ste13* gene was knocked out in *Schizosaccharomyces pombe*. The effect of this deletion on the expression of three genes was examined. These genes are important for the proper execution of cell division and were chosen because they have a high fraction of non-optimal codons and their protein concentrations are known to be important for function. The mRNA levels were quantified by single-molecule fluorescence in situ hybridization (smFISH). Analysis using Fiji and MatLab indicated elevated steady-state mRNA levels as compared to wild-type cells. These results are consistent with the hypothesis that the Ste13 protein in fission yeast acts as a regulator of mRNA half-life dependent on codon optimality. mRNA half-life modulation through codon usage may therefore be widespread across eukaryotes and may have an influence on protein levels and cell-to-cell variation.

## **The Effect of Transition Metals on the Ability of *Escherichia coli* to Replicate**

*Matthew Murray, Central Virginia Governor's School for Science & Technology*

The purpose of this study was to determine which transition metal was most effective at preventing *E. coli* from replicating. The study was conducted by inoculating different metals: copper, lead, and zinc; with .5 mL of a 19-day *E. coli* culture for 24 hours. The metals were washed in a phosphate-buffered saline solution, which was diluted to 1:450. The control groups for each metal were inoculated with distilled water and underwent the same serial dilution procedure. There were eight trials for each of the six groups. After dilution, 100  $\mu$ L of the new solution was plated onto micro petri dishes using pour plate techniques. A one-way ANOVA test determined significance with a p-value of  $5.15 \times 10^{-7}$  and an alpha of .05. A post-hoc Tukey test was performed, which, with a Dmin of 6.96, showed that there was significance between the copper and zinc experimental groups as well as between the lead and zinc experimental groups, with both lead and copper averages being lower than zinc's average. The research hypothesis, which stated that if *E. coli* is exposed to copper, lead, and zinc, then copper will be most effective in preventing *E. coli* from replicating, was fully supported as there was no significant difference between the lead and copper experimental groups. In conclusion, lead and copper are both more effective than zinc at preventing *E. coli* from replicating, but neither are statistically better than one another at preventing *E. coli* from replicating.

## **The Effects of Different Amplitudes of a Particular Song on the Antibiotic Susceptibility of *Escherichia coli* against Ampicillin**

*Shardul Naphade, Central Virginia Governor's School for Science & Technology*



This study analyzed the effect of music on the immunity of *Escherichia coli* K-12 against antibiotics, essentially portraying probiotics. The experiment was conducted at a high school research laboratory. Two original cultures of *E. coli* were made in tryptic soy broth and allowed to grow for two months to ensure adequate *E. coli* was present for the experiment. Four soundproof boxes were assembled with mp3 players and headphones to serve as an incubator where the cultures of *E. coli* received music treatment for 2 hours and 12 minutes at 58.3, 68.3, and 78.3 decibels. The cultures were allowed to grow for 6 days. The treated cultures were then inoculated on 7 petri dishes with an ampicillin disk. After one day of growth, the zone of inhibition was measured and averaged for each experimental group. This process was repeated for 71.2, 80.1 and 87 decibel levels with 9 trials each. The control consisted of *E. coli* without any music treatment, for a total of 16 trials. A one-way ANOVA determined significance ( $\alpha=0.05$ ,  $p\text{-value}=6.5E-09$ ). A Tukey test then determined a  $D_{min}$  of 2.7, portraying a difference in the 87 and 68.3dB vs. 78.3, 58.3 and 80.1dB, thus supporting the research hypothesis that 68.3 and 87dB will have the least average. The results showed that music does have a significant effect on the immunity of *E. coli*, indicating that music can be used for medical purposes.

### **The Effect of Caffeine on Target of Rapamycin complex (TOR)**

*Constance Newell, Mills E. Godwin High School*

### **The Effect of Different over-the-counter Acne products on the Inhibition of *E. coli***

*Angela Nguyen, Mills E. Godwin High School*

The purpose of this experiment was to find the effects of different over-the-counter acne products on the inhibition of *Escherichia coli*. Acne causes not only lesions and inflammation, but also negative psychosocial impacts. Many products have been produced to treat acne, such as benzoyl peroxide, salicylic acid, and hydrogen peroxide. A single colony of the *E. coli* strain K-12 was inoculated with LB. Separate disks were dipped into purified water, 2.5% benzoyl peroxide, 2% salicylic acid, and 3% hydrogen peroxide, and were placed into their corresponding quadrants on nutrient agar plates with the bacteria culture. After three days, the diameter of the zones of inhibition were measured. The control used in this experiment was purified water. It was hypothesized that if 2.5% benzoyl peroxide was used, then it would inhibit the growth of *E. coli* the most. The results revealed that hydrogen peroxide had, on average, an inhibition zone size 7.1mm greater than salicylic acid, 9.2mm greater than benzoyl peroxide, and 18.8mm greater than water. This shows that the results did not support the research hypothesis. Multiple t-tests were performed on the data, which revealed that the data was statistically significant. It is believed that the oxidizing properties of benzoyl peroxide would be more toxic to *P. acnes* than *E. coli* because *E. coli* can grow in the presence of oxygen. Salicylic acid could inhibit the growth of *E. coli*, but not as well as hydrogen peroxide because it targets comedones, while hydrogen peroxide acts as a biocide for bacterium.

### **Solar Water Disinfection**

*Lily Odenwelder, Washington-Lee High School*

## **Antiproliferative Effect of Rapamycin against Phenylephrine Induced Cardiac Fibrosis**

*Shakthi Ramasamy, Mills E. Godwin High School*

Cardiac fibroblasts play a critical role in maintaining normal cardiac function. Cardiac fibrosis, due to abnormal proliferation of fibroblast cells, leads to adverse remodeling and heart failure. Limiting proliferation of fibroblast cells could be beneficial in inhibiting cardiac fibrosis. mTOR signaling plays an important role in regulating cell proliferation and governs the integrity of cell growth. Rapamycin is known for its immunosuppressant, cardioprotective, anti-proliferation properties, and is a potent inhibitor of the mTOR complex. Rapamycin could be a viable drug that can impede the proliferation of fibroblast cells and prevent the development of cardiac fibrosis. Phenylephrine, induces proliferation of fibroblast cells, leading to cardiac fibrosis. To evaluate rapamycin's antiproliferative properties, fibroblast cells isolated from primary neonatal rats were subjected to proliferation with phenylephrine (100 $\mu$ m) and treated with or without rapamycin (100nM) for 48hrs. Initially, several doses of phenylephrine (50 $\mu$ m, 100 $\mu$ m and 200 $\mu$ m) were tested to determine the appropriate concentration to induce proliferation without cytotoxicity. The Trypan blue cell exclusion assay was performed to measure mean percentage of nonviable cells. The MTS assay was performed to measure proliferation rate of cells. 100 $\mu$ m of phenylephrine increased the number of cells, and cell death increased with 100 $\mu$ m phenylephrine treatment. Cell death decreased upon rapamycin treatment. The cell proliferation rate was higher with phenylephrine treatment and reduced upon rapamycin treatment. In conclusion, rapamycin could reduce the proliferation rate and necrosis of fibroblast cells induced by phenylephrine. Treatment of fibroblast cells with rapamycin may be a novel approach to arrest abnormal cell proliferation, cardiotoxicity, and attenuate cardiac fibrosis.

## **The Effect of Sugar on Soil's Electroactivity Produced by Bacteria**

*Elina Rastegar, Mills E. Godwin High School*

Recently, scientists have been investigating alternative methods of producing electricity, such as microbial fuel cells. This technology has the ability to generate clean energy using microorganisms in soil without burning natural resources, thus preventing the progression of global warming. This can improve human health and restrict potential disasters, thereby being environmentally and economically beneficial to society. In the experiment, 0 grams, 0.5 grams, and 1.5 grams of sugar were added to the microbial fuel cells in order to investigate their ability to enhance the electricity output of the fuel cells. The group with no additional sugar was selected as the control group of the experiment. Moreover, it was hypothesized that if more sugar is added to soil, then more electricity will be produced by bacteria. To test the research hypothesis, microbial fuel cells were built, and various grams of sugar were added to the soil. Then, the electricity output was measured using a multimeter. The bacterial electricity production was shown to have a higher value with 0.5 grams of sugar compared to 1.5 grams of sugar, therefore rejecting the research hypothesis. Furthermore, a t-test was performed and revealed the observed data to be statistically significant, meaning the results were most likely due to changes in the independent variable versus other factors. It was concluded that optimal grams of sugar can help bacteria reproduce more rapidly, allowing them to generate more electricity.

Lastly, further investigations could be done on other food sources to improve the efficiency of this technology.

### **The Effect of Various Seed Oils on Fermentative Metabolism**

*Katie Selvaraj, Mills E. Godwin High School*

The purpose of this experiment was to determine if seed oils had an effect on the fermentative metabolism of *Saccharomyces cerevisiae*, also known as brewer's yeast. One approach that scientists have taken to eliminate cancer is to target the tumor cell metabolism, which is extremely similar to mechanisms behind the fermentative metabolism of yeast cells. Thus, the results of this experiment may be extended to cancer research. In this experiment, yeast was treated with either pumpkin seed oil, rapeseed oil, or sunflower seed oil, and the control used was no oil. After ten minutes, the amount of carbon dioxide produced was measured. It was hypothesized that if sunflower oil was used, then the yeast would have the highest metabolic rate. The results indicated that yeast treated with no oil had the highest fermentative metabolism, and yeast treated with rapeseed oil had the lowest fermentative metabolism. A t-test was performed on the data, and all of the data was significant with the exception of sunflower oil versus pumpkin seed oil. Therefore, the results did not support the research hypothesis. The results possibly occurred because rapeseed oil has properties such as high smoke point as well as high concentrations of erucic acid the sunflower and pumpkin seed oils do not possess. This research could lead to further studies that investigate other seed oils and how other forms of these seeds may affect fermentative metabolism.

### **The Effect of Concentration of Colloidal Silver and Gram Positive or Negative Bacteria on Zone of Inhibition**

*Hamna Shafiq, Washington-Lee High School*

This research was conducted to test the effect of colloidal silver and gram positive or negative bacteria on zone of inhibition. There is little prior research on the effectiveness of colloidal silver as an antimicrobial agent and the findings are not consistent. When the silver nanoparticles in the colloidal silver come in contact with the bacteria it disables its oxygen metabolism enzyme. The nanoparticles attach to the cell membrane and damage the DNA making it impossible or hard for pathogenic bacteria to replicate itself. The hypothesis: If the different concentrations of colloidal silver will be used on *Escherichia coli* (gram negative) and *Bacillus subtilis* (gram positive), then the 50% solution will have the smallest zone of inhibition on the gram-negative bacteria because its cell membrane is extremely difficult to penetrate. The IV levels were: gram-positive (*B. subtilis*) vs. gram-negative bacteria (*E. coli*) and 250 vs 500 (ppm) of colloidal silver. First the petri dishes were prepared with nutrient agar. Then the dishes were inoculated with the *E. coli* and *B. subtilis*, and the sterile discs dipped in colloidal silver were placed in every quadrant. The petri dishes were sealed and incubated for 48 hours. The data was collected from these petri dishes using the zone of inhibition and observations of type of growth. The mean zone of inhibition was larger for the 250ppm colloidal silver compared to the 500ppm. The standard deviations for both concentrations of colloidal silver on gram-negative bacteria were very high, which suggests a large margin of error. The ANOVA test gave a p-value of 0.99 which is much larger than 0.05. A t-test between the two concentrations on colloidal silver among the gram-negative bacteria provided a p-value of 0.052. There is

no statistically significant difference between the concentrations of colloidal silver used. The p-value of a t-test between the gram-positive and gram-negative groups gives a p-value of  $9.7E-07$ . Due to the high level of uncertainty, this difference could be a result of experimental error.

### **How Rougher Locations on the Thomas Jefferson Memorial Affect Biofilm Growth**

*Adam Stievater, Washington-Lee High School*

The purpose of the experiment was to find the effect of surface roughness of the Thomas Jefferson Memorial on microbial growth. The hypothesis was that if the roughness of the swab location increases, then the area occupied by biofilm will increase, because there will be a greater concentration of biofilm in rougher locations. The mean microbial growth when the smooth surface on the Thomas Jefferson Memorial was sampled was  $2.36 \text{ cm}^2$ , while the range was  $6.88 \text{ cm}^2$ , and the standard deviation was  $1.93 \text{ cm}^2$ . The mean microbial growth when the rough surface was sampled was  $9.07 \text{ cm}^2$ , while the range was  $5.78 \text{ cm}^2$ , and the standard deviation was  $1.99 \text{ cm}^2$ . The mean microbial growth when a sterile swab was used was  $0.36 \text{ cm}^2$ , while the range was  $1.25 \text{ cm}^2$ , and the standard deviation was  $0.6 \text{ cm}^2$ . The error bars do not overlap on the summative graph, implying statistical significance of the results. That statistical significance rejects the null hypothesis. It was found that there was more microbial growth with increased surface roughness thus supporting the hypothesis. Since weathering can increase surface roughness, and there was more microbial growth when a rough area was swabbed, the Thomas Jefferson Memorial may be experiencing more biofilm presence than before because the memorial has weathered more.

### **A Study on the Antibiotics Resistance of Bacteria Found in Conventionally Raised Poultry**

*Catherine Sword, Yorktown High School*

The goal of this experiment is to examine bacteria found in the meat of conventionally raised poultry and test how resistant they are to common antibiotics. When humans consume this meat, they also eat whatever bacteria were living in the meat, inoculating themselves with possibly antibiotic resistant bacteria. If the reports are true, the bacteria from the poultry will display some form of resistance to the various antibiotics used in factory farming. The bacteria should be able to overcome some of the antibiotics and be unaffected by them, ignoring the zones of inhibition, or the area around the antibiotic dose in which the bacteria won't grow.

### **The Effect of Light Exposure on Dinoflagellate' Bioluminescence**

*Leem Taha, Mills E. Godwin High School*

Since the 20th century, the concentration of Earth's oxygen has decreased exponentially due to global warming. The dinoflagellate, *Pyrocystis fusiformis* protects itself using bioluminescence to produce oxygen. The oxygen contributes to a needed solution for global warming, making research on bioluminescence essential. The purpose of the experiment was to test and analyze the effect of different light exposures on *P. fusiformis*' bioluminescence. The cultures were exposed to three cycles: Light/Light, Dark/Dark, and Light/Dark for a period of seven days. It was hypothesized that if the cultures maintained a Light/Light cycle, then the bioluminescence recorded would be higher than the other

levels. Every day for a week, the cycles rotated, and the bioluminescence was recorded using a luminosity scale created based on prior studies. The control of the experiment was the Light/Dark cycle. The results displayed that the Light/Light cultures had a higher median than the control by 0.2 and the Dark/Dark cultures had a lower median than the control by 1.4. A chi-square test was performed, and the results revealed that the data was significant for all three tests. Thus, the research hypothesis was supported. The probability of the results being due to chance was less than 0.05 and implied that the results of the experiment were most likely due to the independent variable and not chance or error. For further experimentation, findings may be more significant after longer periods of experimentation.

### **Peptide Nucleic Acids as Potential Designer Antimicrobials**

*Unmesha Vullikanti, Blacksburg High School*

The overuse of antibiotics in many aspects of daily life - from household cleaners to hand soaps - has ushered in a wave of resistance to antibiotics. Resistance to antibiotics is spread between bacteria through various mechanisms of gene transfer and mutation but can be prevented through antisense therapy, or gene regulation, to monitor and reverse resistance. Peptide nucleic acids (PNAs) are short synthetic nucleotide sequences manufactured with a peptide backbone instead of the standard ribose backbone and complementary to the starting sequence of a given gene. This treatment can be used to inhibit specific protein synthesis by binding to the target gene as well as associated mRNA, as shown in previous studies where PNAs have targeted essential genes and resistance mechanisms. In this experiment, PNA treatments were targeted for the essential gene *tsf* and the associated tetracycline resistance mechanisms TetA & TetR in *Salmonella typhimurium*. These synthetic molecules, attached to cell-penetrating peptides (CPPs) to facilitate uptake into the cell, were incubated with *S. typhimurium*-infected macrophages across a range of tetracycline concentrations to determine efficacy of PNA treatments in inhibiting growth. In a separate experiment, PNA treatments were tagged with Tuftsin a marker protein found in macrophages that induces endocytosis, in order to facilitate better uptake of the PNA treatments. It was discovered that PNA treatments are somewhat inhibitory to bacterial growth in vivo; however, tetracycline alone was shown to be equally, if not more, effective. Treatments tagged with Tuftsin proved more effective than without Tuftsin inhibiting growth at a greater level. Ultimately, the PNA treatment was less effective in vivo than in vitro but still continued to significantly inhibit bacterial growth.

### **Are Hand Dryers Actually Hygienic?**

*Sally Work, Washington-Lee High School*

### **Physical Science and Astronomy**

#### **Investigating the Variation of Speed of Sound with Air Temperature**

*Nicholas Artiedamarin, Mary Ellen Henderson Middle School*

The objective of this research was to study how air temperature affects the speed of sound. This is important because the temperature affects the transmission of emergency

sound remote signals. The researcher hypothesized that the higher the air temperature, the faster the speed of sound. To collect the data, one person filmed another person clapping two wooden blocks together within a specific distance between the two people. The experimenter measured the speed of sound at different temperatures using a video editor software. Using the software, the experimenter measured the time elapsed between the visual clapping and the sound clapping by calculating the frames per second (fps) between these two moments. The researcher calculated the speed of sound using the distance between the two people and dividing by the measured time converted to seconds. The results from the experiment showed that as the temperature outside increases, the speed of the sound transmitted increases. The results showed that the camera with 60 fps had a trend that was similar to the theoretical formulation. The results obtained using a 30fps camera was inconclusive, there was not a clear trend on the measured speeds with temperature variation. The speed didn't increase with increasing temperature for all cases. Because of the dispersion and variation of the data the experimenter could not get results to form an accurate trend. In this work the experimenter learned that there are different ways to calculate the time elapsed between visual and sound signal, but the method used can affect the precision of the data. The experimenter discovered that he could use video editing software to measure the number of frames in between the visual and sound signal. This was a new way of measuring the speed of sound at different temperatures.

### **Ball Bounce, Energy Loss**

*Carolyn Bohnert, Swanson Middle School*

This project occurred when a basketball was dribbled, and someone said the ball wasn't dribbled fast enough. After looking up different projects, the concept of potential energy loss of a basketball was thought to work well and would allow for a way to scientifically measure energy. That led to researching a few main topics, such as height affecting potential energy and mass affecting potential energy. In the process, it was discovered that potential energy is more than just used for small things; it is also used in things such as energy production of dams. The project was approached by dropping a basketball from different specific heights and finding the potential energy from the drop height and from the first bounce height. This led to finding the difference of those two potential energy results to get the potential energy loss and then graphing that to see if there was a proportionality and correlation between the drop height and the potential energy loss of the basketball. The hypothesis was that if the basketball was dropped from a larger height, there would be more potential energy loss of the basketball. At the same time, it was thought that the drop height of the basketball would be proportional to the amount of potential energy loss of the basketball. After the results were calculated, it was noted that there was a clear, positive correlation between drop height and the amount of potential energy loss of the basketball, but at the same time there was no proportionality between the drop height and the potential energy loss of the basketball. In conclusion the results were inconclusive; the data does not show the first bounce energy loss to be perfectly proportional to the potential energy from the drop height of the basketball. The energy loss shows a positive correlation, but the amount of loss increases at a more than proportional amount as the drop height of the basketball is first doubled, then tripled.

## **The Physics of a Magnetic Linear Accelerator**

*Farouk Boudjemaa and Cameron Gleaton, Swanson Middle School*

Magnets are used everywhere, from sealing refrigerator doors to MRI scans. Their applications are endless, and they have allowed for advancements in countless fields, one being computer science. The purpose of this project is to discover which magnet is the most powerful. This project assesses the effect of various types of permanent magnets used in a magnetic linear accelerator on the distance and velocity of the launched projectile. The magnets tested were Neodymium, Samarium-Cobalt, Alnico, and Ferrite. The hypothesis was that if a Neodymium magnet was used in a magnetic linear accelerator, then the distance and velocity would be greatest. The experimental results supported the hypothesis by showing that Neodymium magnets resulted in the farthest distance traveled and the highest velocity reached. The experiment also showed that magnets comprised of rare-earth elements such as Neodymium and Samarium-Cobalt are far more powerful than regular permanent magnets like Alnico and Ferrite. Rare-earth magnets are stronger because of the arrangement of their electrons. In most materials, all the electrons are in pairs with opposite spins, canceling the magnetic field. In rare-earth magnets, however, many electrons are not paired, causing the magnets being much more powerful.

## **The Effect of the Type of Light bulb on the Current, Light Output and Temperature**

*Isla Carlson, Gunston Middle School*

In this experiment, the light output (lux), temperature ( $^{\circ}\text{C}$ ), and current (amps) was measured to find the most efficient light bulb. This experiment measured the effect of the type of light bulb on the current (amps), temperature ( $^{\circ}\text{C}$ ), and light output (lux). The light bulbs tested were Halogen, LED, Incandescent, and Fluorescent. The light bulbs were left on for 10 minutes, at two minutes the current (amps) was measured, then at five minutes the light output (lux) was measured. Finally, at ten minutes the temperature was measured, this allowed the light bulb to heat up. The light bulb with the highest temperature was Halogen with  $59.68^{\circ}\text{C}$ . At this temperature this light bulb could be dangerous in a home. The most temperature efficient light bulb was the LED which was only  $23.14^{\circ}\text{C}$ , which is very close to the temperature the experiment was started at ( $21.1^{\circ}\text{C}$ ). The Halogen light bulb gave out more light (29,708 lux) and the LED light bulb was a close second (26,546 lux). This experiment will show home designers, electricians, and many more the most efficient and safest light bulb to use. The researcher learned the most efficient light bulb is a matter of opinion. If a consumer's goal is to have the brightest light bulb Halogen is the choice, and if a consumer wanted the safer option an LED light bulb should be used.

## **The Effect of Snare Drumhead Tension on the Length of Sustain**

*William Chenoweth, Williamsburg Middle School*

The effect of snare drumhead tension on length of sustain was investigated to learn if the length of the sustain after a snare drum is hit can be shortened by tuning the snare drum head tighter or looser. The experiment was conducted by tuning the drumhead to the desired level of IV, dropping a ball onto the drumhead from a constant height, and recording the length of the sustain using the voice memos app on an iPhone. The data showed a definite correlation between snare drumhead tension and length of sustain. The

general trend showed that the tighter the snare drumhead was tuned, the shorter the sustain would be.

### **Physics of a String**

*Evelyn Courard-Durso and Frances O'Malley, Swanson Middle School*

#### **The Effect of Dance Footwear on Rotational Friction**

*Sydney Douthit, Sabot at Stony Point*

#### **The Effect of Simulated Use on Tennis Ball's Softness**

*Owen Eklund, Sabot at Stony Point*

A brand-new hard court tennis ball will lose its pressure or become more compressible after use but there is minimal research showing how certain amounts of compressions or amounts of use affects tennis balls. This experiment was conducted to determine what effects simulated use (200, 400, 600 and 800 compressions) has on a set of tennis balls. The experiment used a compressor (made from wood and a hinge) to simulate normal use by compressing a set of tennis balls to 3.5 cm or half of their original diameter. The force required to compress each ball to 3.5 cm was measured before and after each set of simulated use. The data from the test gave a decrease in compression force which shows how much more or less force it took to compress each ball after simulated use. The hypothesis was that balls compressed 800 times would show the largest increase of compressibility after simulated use. The data from the 800 compressions supports the statement, showing the biggest increase of compressibility but the data from the other compressions does not support statements about them from the hypothesis.

#### **The Effect of Different Roof Colors on Building Temperatures**

*Juliet Geers, Thomas Jefferson Middle School*

The purpose of this study was to find out the effect of different colored roofs on building temperature. The independent variable was the different color of roofs. The experimental group included the white roof and green roof. The control group was the black roof. The dependent variable was the temperature inside of each model house after a few days of sitting outside. The constants included: the model houses, the material of the black shingle, and the environment in which they will be sitting for two days. The hypothesis was: The model house with the white roof will have the coolest interior temperature. Overall, to perform this experiment there was three model houses, one with a plain black roof, one with a plain black roof painted white, and one plain black roof with dirt, grass and other various plants. The results showed that the white roof did indeed have have the coolest temperature. The primary reason the experiment supported the hypothesis was likely that the white roof reflected sunlight away from the building, and that led directly to the cooler temperature inside the model. In conclusion, this study suggests that black roofs are not ideal for hot weather environments, or perhaps in urban areas generally speaking.

#### **The Effect of Frequency on Acoustic Panel Effectiveness**

*Scott Gowdy, Thomas Jefferson Middle School*



### **The Effect of Dirt on Solar Energy**

*Rose Haron, Swanson Middle School*

The purpose of this experiment was to test the effect of dirt on solar energy. This experiment ties to the concept of solar-powered roads, which are roads that also have the capacity to generate solar electricity. Solar roads can have many logistical issues. First, solar panels work best when tilted at an angle, and roads lie flat. Second, vehicles and weather patterns can track debris onto roads. Such debris includes snow, dirt, and dust. This experiment tested how dirt and debris affect solar panels' ability to generate power. For this experiment, solar panels were placed under LED lamps for 10 minutes at a time. Each solar panel had a different amount of dirt placed on top. Afterward, the energy output of each solar panel was measured, and the testing process repeated 9 more times. The hypothesis was that if no dirt was added to the panels, then those panels would generate the most electricity, because there would be no dirt to block out the panels' energy source. The results supported the hypothesis that no dirt allowed the most energy to be generated. The average power output for no dirt was 0.21 milliwatts, the average for 25g of dirt was 0.012 milliwatts, and the average for 50g of dirt was 0.0008. These results show that the panels with no dirt generated the most electricity, and it was proven that dirt does affect solar energy.

### **The Effect of Different Materials on the Reflection of Sound**

*Dylan Hill-Joyce, Sabot at Stony Point*

Acoustics are an important part of presenting, something which many students have to do. The acoustics of a room can affect how loud one has to be in order to be heard by an audience. This experiment was designed to test for the best reflective material, as reflective materials are an important component of room acoustics. If a presenter is surrounded only by absorbent materials all of the sound they make will be absorbed into those materials, making it difficult to be heard by an audience. If a presenter is surrounded only by reflective materials then all of the sound they make will be reflected, so much so that there will be too much of an echo to make out the original speech. In order to create a room with optimal or even decent acoustics, it is necessary that there is a balance between reflective and absorbent materials. To create a room with balanced reflective and absorbent materials it is crucial that the sound reflection properties of different building materials be understood. This experiment tested soda lime glass, concrete, Carrara marble, oak wood, and steel to understand which was most reflective with regard to sound. The data showed that oak wood reflected the most sound during this experiment however it is hard to determine if oak wood would be the most successful at reflecting sound as there was so much overlap in the data. Carrara marble, oak wood, and steel were the most reflective and all had very similar results. Soda lime glass and concrete were significantly lower than the rest, although the soda lime glass data showed a somewhat higher sound reflective property than the concrete did.

### **The Effect of the Amount of Salt on the Rate of Corrosion**

*Esha Kidambi, George H. Moody Middle School*

Salt is found all over the world and has a great impact in our day to day lives. Corrosion is collapsing of a metal with the result of chemical reactions between the metal and the things surrounding it. Steel nails are used to make ships, boats, houses and other

equipment. This research analyzes the impact of salt on steel nails. In this research, an experiment was done to understand the impact of saltwater on steel nails. The steel nails were emerged in different concentrations of saltwater solutions for ten days' time and at room temperature. Ten trials were made with six different types of saltwater solutions. Periodic observations were made to observe the rate of corrosion. In order to measure the rate of corrosion, a classification corrosion rating key was made based on the changes in the color of the saltwater and the rust found on the nail. The mean, median and mode average of the classification key were all computed. The results were that the higher concentration of saltwater solution, the higher the rate of corrosion. The maximum amount of corrosion was observed in the highest concentration of saltwater solution. For future research, the same methodology could be used for different metals such as iron nails or other types of nails. Furthermore, this research can be extended to study the impact of the rate of corrosion under different temperatures and different humidity conditions.

### **The Effect of Texturing Piston Rings on Friction**

*Lorenzo Mazzeo, Sabot at Stony Point*

The piston engine was invented in 1859 by a French engineer J. J. Étienne Lenoir, since then there have been many improvements such as texturing the piston rings to reduce friction and increase efficiency. Although piston engines are effective, and we use them in our everyday lives to get places they have a serious toll on the environment and speed up the effects of global warming. This experiment was conducted to see how well texturing the surface of the rings on the piston would impact the engine's efficiency. The experiment was conducted by pushing different pistons down the cylinder and recording the force required. The results showed the reduction of friction as a result of the divot texturing was statically significant in comparison to that of the control (with a p value of 0.00233029). Unfortunately, the X-texturing was not significant in comparison to the control (with a p value of 0.05531444). The experimental data suggest that texturing does reduce friction in an engine.

### **The Effect of Increasing Heat on Flywheel Speed of a Stirling Engine**

*Tom Meyers, Sabot at Stony Point*

### **Skin Effect Loss with Waveform**

*Ryan Mickelwait, Peter Muhlenburg Middle School*

The purpose of the experiment was to find out the effect of waveform on skin effect depth in high frequency AC. It was hypothesized that if the waveform had a steeper slope, then the skin effect depth would be shallower (less usable conductor). To test this hypothesis the procedures were to run a high frequency AC signal through a length of copper wire. The voltage was measured at different frequencies, and the frequency at which there was a voltage increase would be when the skin depth dropped below the radius of the wire. In the end it turned out that there was no change in voltage when the frequency increased. The results do not support the hypothesis. This was most likely because the voltmeter could not measure at high enough frequencies.

### **The Effect of the Type of Magnet on How Much Mass the Magnets Can Support before Touching**

*Emma Pericak, Swanson Middle School*

My experiment found which magnet held the most weight while repelling. I was interested in hovercrafts and many stay up with repelling magnets. Hovercrafts usually need to hold lots of weight therefore the goal was to find a strong magnet. When researching, I found three exceptional options for metals in magnets: neodymium, samarium-cobalt, and alnico. After other research, I made my hypothesis that the neodymium would perform best because it is a rare-earth metal. I made three contraptions to help in testing the magnets. First, a straw and supports hot glued straight up on a piece of cardboard held the magnets in a vertical position. The other two contraptions were dowels with containers on top that held marbles, which I used for weight. The containers were different sizes because one magnet was not strong enough to hold the larger container. I placed the magnets inside the straw of the first contraption, placed it on a scale and zeroed it out. The magnets inside the straw of the first contraption were repelling. Then I put one of the other contraptions on top. I added marbles to the container of the second contraption until the magnets touched and recorded the number of grams it took for them to touch. The data supported my hypothesis. The neodymium held the most, over 1000 g each time; the samarium-cobalt held about 650g each time; finally, the alnico held around 50g each time. The data sets did not overlap, so any experimental errors made did not largely impact the results. Conclusively, neodymium is best from what I tested.

### **Exploring How Sound Frequency Affects Distance Traveled**

*Emerson Rose, Sabot at Stony Point*

Many construction companies are always trying to decide where the best area is to build any type of structure, whether that being a house, apartment, or school. The purpose of this experiment was to determine what level of frequencies of sound would travel the farthest when compared to low, medium, and high scales. A decibel meter was used to measure the volume of the sound for every frequency, the frequencies were played out of an overhead speaker system held in the ceiling, and an iPad was used to control which frequencies were played. The frequency levels tested were low being 50Hz-900Hz (starting at 50Hz and going to 100hz, then increasing by 100hz), medium being 1,000Hz-9,500Hz, and lastly high frequencies being 10,000Hz-15,000Hz. Each frequency was measured at each tested distance, and then the volume was measured using the decibel meter. When comparing the mean of the volume at each given distance (source, 2.5m from source, 6m, 11.5m, and 6m to the outside which is separated by a wall), the data shows that the low frequencies were the only level to not have a decrease in volume by every distance, the medium frequencies started louder than the low frequencies but then decreased in volume as the distance increased, the highest frequencies started lower than any other level, and then decreased. This shows that low frequencies of sound when compared to the medium and high frequencies, travel the farthest.

### **The Effect of Wrist Width on Forearm Pass Height of a Volleyball**

*Sophia Smith, Sabot at Stony Point*

Volleyball is a sport played on a court with six players on each side with a net in the middle of the court. The goal of the game is to volley the ball back and forth over the net using the hands, forearms, and wrists. Volleyball has been played since 1896 starting in Massachusetts. Then volleyball spread to Canada, China, Japan, Mexico, Puerto Rico,

South America, Africa, and Europe. There are three main types of passes in volleyball. A bump pass, a set, and an attack. A pass is a way of getting the ball up into the air high enough to go over the net. The bump pass is the easiest and most basic type of pass in volleyball. A bump pass is a pass where a “platform” is created with the forearms for the ball to bounce off. The elbows should be locked to keep the forearm platform flat and straight. This experiment was designed to test whether wrist size affects a volleyball bump pass. There were three different widths of pvc piping tested to act as the forearms when bumping a volleyball. The hypothesis for this experiment was that the medium size would make the volleyball bounce into the air the highest out of the three different widths of pvc piping. This was because after the research was done, it was hypothesized that the larger size of PVC piping would have too much surface area and would absorb the energy and the smallest size would not have enough surface area for the ball to bounce off. After this experiment was completed, it was shown in the data that the hypothesis was supported, and the medium ball had the highest height after the pass. However, the ranges between each wrist width was very little and each trial overlapped significantly. This means that wrist width does not affect a volleyball bump pass significantly. It was thought that the wrist width may not affect the height of the pass, but the force needed to pass the volleyball. The range between the three wrist widths was approximately 0.02 meters.

### **The Effect of the Temperature on the Bounce Height of a Tennis Ball**

*Parvathi Tadi, George H. Moody Middle School*

The purpose of this experiment is to measure the effect of a change in temperature on the bounce height of a tennis ball. The experiment will show what temperature makes a tennis ball bounce higher. If the temperature of the tennis ball is increased, then the height of the bounce of the tennis ball will increase. The experimenter first collected thirty-five tennis balls. Then, the experimenter took five tennis balls and labeled them “control”. The experimenter took the five balls and bounced them from a meter height. The experimenter noted the height and repeated this process six more times. The second time, the experimenter labeled the balls “freezer”. The balls were left in the freezer for thirty minutes. The experimenter repeated the method. The third time, the experimenter labeled the balls “fridge”. The tennis balls were put in the fridge for thirty minutes. The experimenter repeated the procedure. The fourth time, the experimenter labeled the balls “cold tap water”. The experimenter puts the tennis balls into cold water and repeated the process. For the fifth time, the experimenter labeled the tennis balls “sun”. The experimenter places the tennis balls in the sun for thirty minutes. Then the experimenter repeated the procedure. For the sixth time, the experimenter labeled the balls “hot tap water” The experimenter placed the tennis balls in hot water for thirty minutes. The experimenter repeated the process. On the seventh time, the experimenter labeled the balls “boiling”. The experimenter placed the balls into boiling water and repeated the process. The results supported the hypothesis. While the experiment was being conducted, the experimenter observed that, as the temperature began to rise, the tennis ball gradually bounced higher and higher. In the future, the experimenter could improve this project by using different types of balls.

### **The Effect of Wind Speed on the Distance Water Travels**

*Sophia Voulgaris, Thomas Jefferson Middle School*

The purpose of the study was to see the effect of wind speed on the distance water travels inland from the coast. The independent variable was the wind speed. The experimental group included these levels: 8.5 mph, 20 mph, 35 mph, 55 mph, 61 mph, and 70 mph. The control group was no wind. The dependent variable was the water level difference. The constants included the location, amount of water, and container used. The hypothesis was: If the wind speed is 70 mph, then the water will go farther inland than the average shore level. Water was put in a tray and different wind speeds were tested. The results showed that the higher the wind speed, the larger the water difference, meaning larger storm surge. These results accepted the hypothesis. In conclusion, the study suggests that the stronger winds the stronger and more powerful storm surge.

### **The Effect of Lifting Envelope Volume on Hot Air Balloon Lift**

*Jason Woodworth, Kenmore Middle School*

### **Physics and Astronomy**

### **The Effect of Temperature on the Pressure Change in a Football**

*Carter Blanks, Clover Hill High School*

### **The Truth Hertz: The effect of different materials on sound reducing capabilities**

*Joy Block, Arlington Career Center*

The purpose of this experiment was to find out the effect of different materials on their sound reducing capabilities. It was hypothesized that the carpet would reduce sound the most due to its higher density. To test this hypothesis the procedures involved lining boxes with the different materials, placing a speaker in the box with a decibel reader 1 meter away, and recording the dBs measured from different pitches. In the end it turned out that overall carpet did the best job reducing sound especially for the higher pitches tested. The felt did slightly better with the lowest pitch tested.

### **The Effect of Delivery Methods of Acetaminophen on its Dissolvability**

*Amulya Chowdhory, Mills E. Godwin High School*

The purpose of this experiment was to find the effects of delivery methods of acetaminophen on its dissolvability. Acetaminophen, a commonly used drug, has not been studied in depth. Researchers have little knowledge about some characteristics of the drug- such as the side effects and the potential addictiveness. The levels of independent variable were Extra Strength Caplets, Rapid Release Gels, and Extra Strength Coated Tablets, which were in dosages of 500 mg. The hypothesis was that if the delivery methods of acetaminophen were dissolved in a gastric acid-like solution, then the caplets would dissolve the fastest. There was no method of acetaminophen that was statistically showed popular or that was naturally produced, as a result, there was no control. Therefore, the levels of independent variable were compared to one another for the results. Each trial of independent variable was placed in a gastric acid-like solution and which was allowed to dissolve which was measured in seconds. T-tests were conducted to conclude if the data was statistically significant at the degrees of freedom of 48 and the level of significance of 0.05 with the probability value of 2.24. The calculated t-values were for gels versus caplets was 1.149, caplets versus tablets was 23.623, and

tablets versus gels was 12.364. Most of the data was not statistically significant. The research hypothesis was not supported by the data. Rapid Release Gels were supported because they dissolve the fastest because they had the lowest mean, which was around 4 minutes.

### **The Effect of Repurposed Materials on Thermal Insulation**

*Michael Dertke and Kyle Wilson, Washington-Lee High School*

This experiment studied the thermal insulation properties of repurposed materials. The purpose of this experiment was to find repurposed materials that could be used as effective thermal insulation. Heating and cooling buildings is a large part of the energy cost of modern society and effective thermal insulation can reduce energy consumption. Current thermal insulators can be expensive and dangerous to workers and inhabitants. A solution to this is to use commonly repurposed materials as thermal insulators. The materials tested were; clothing, fiberglass pipe insulation, cardboard, newspaper, aluminum, and no insulation was used as the control. The hypothesis was that if fiberglass pipe insulation is used, then the temperature will decrease the least due to fiberglass' low density and high air content. This hypothesis was partially supported by the data because the fiberglass was one of the best insulators behind clothing and newspaper. The best insulators were, in decreasing order, clothing, newspaper, fiberglass, cardboard, nothing, and aluminum foil. An ANOVA test was run and discovered that there was statistical significance in the data and thus the null hypothesis was rejected. This conclusion is supported by research because clothing has shown very low thermal conductivity making it an ideal insulation material. The materials with low density and high air content were the best thermal insulators due to air being a poor conductor. Certain concerns still must be tested like the flammability of clothing and newspaper, but this could be solved with a fire retardant.

### **The Efficacy of Different Soccer Headgear on Reduction of Impact Force from Collisions**

*Connor Dunlop, Central Virginia Governor's School for Science & Technology*

### **The Effect of Different Types of Flooring on the Height a Basketball Will Bounce**

*Olivia Ebert, Clover Hill High School*

### **Property Study of the Globular Cluster NGC 6266**

*Charley Inman, Central Virginia Governor's School for Science & Technology*

The purpose of this study was to identify three major properties of the globular cluster NGC 6266: tidal radius, mass, and rotation. These properties were found by plotting the cluster's right ascension (RA), declination (Dec), proper motion, color, gravity, and parallax, and determining its star membership. A rotation,  $-0.047 \pm 0.381$  mas/yr, and a tidal radius, 6.73 parsecs, were identified; however, two different masses were obtained from the cluster membership that cast doubt on the accuracy of the cluster membership selection. Using a one sample t-test, it was confirmed that there was significant rotation in the cluster, with a p-value of  $7.3 \times 10^{-7}$  and an alpha of .05. The research hypothesis was retained because tidal radius, mass, and rotation were all able to be derived from a

cluster membership. The goal of this study, to find the properties of NGC 6266, was achieved and offers potential for further research opportunities.

### **The Effect of Golf Ball Dimple Patterns on the Distance the Ball Traveled**

*Anthony LoBosco, Clover Hill High School*

### **The Effect of Different Types of Glass on the Speed of Light**

*Laurel Logan, Central Virginia Governor's School for Science & Technology*

The purpose of this experiment was to determine the effect of different types of glass on the speed of light for the purpose of fiber optic communication. Five different glass samples (BK7, CaF<sub>2</sub>, ZnSe, sapphire, and fused silica) were tested in a spectrophotometer to determine the percent of light reflected which was then translated into the speed of light. The research hypothesis stated that if the speed of light is found in different types of glasses, then it will be fastest in fused silica. This was not supported because the fused silica did not show a statistical difference in the speed of light from any other glass in the 700 nm trial and was only faster than sapphire in the 600 nm trials. The inferential tests used to determine this were two separate ANOVA tests, one for each wavelength. These yielded a p-value of .000521 for the 600 nm test and a p-value of .00399 for the 700 nm test, while the alpha value was .05. Post Hoc Tukey tests then showed that at 600 nm, BK7 and CaF<sub>2</sub> allowed for light to travel significantly fastest, and at 700 nm, it traveled fastest through CaF<sub>2</sub>.

### **The Effect of Deflated Footballs on Game Performance**

*Colby Mandeville, Central Virginia Governor's School for Science & Technology*

The purpose of this study was to determine if the New England Patriots gained a significant advantage from deflating their footballs in the 2015 American Football Conference Championship. One football was used, which was tested at 11.0 psi and 12.5 psi. The catching ability was tested by measuring the indentation made in a bucket of sand when dropped from eight meters. The gripping ability was tested by finding the coefficient of friction for the two inflation rates. The throwing ability was tested by measuring how far a football passing machine could launch the football. The means for the 11.0 psi and the 12.5 psi football in the catching test were both 3.56 cm. For the gripping test they were 1.4 and 2.1, and for the throwing test they were 141.6 feet and 135.8 feet, respectively. A two-sample t-test with an alpha value of .05 was used to test the significance of each of the experiments. The p value for the catching test was 1, for the gripping test .03, and .11 for the throwing test. The results partially supported the research hypothesis, which was that if an American football is deflated to 11.0 psi, then it will be easier to catch, grip, and throw than a football inflated to 12.5 psi. In summation, the inflation of an American football does have an effect on game performance.

### **Studying Properties of Globular Cluster NGC 6712 Based on Star Membership**

*Madison Markham, Central Virginia Governor's School for Science & Technology*

The purpose of this study was to use data from the Gaia DR2 to verify the properties of - globular cluster NGC 6712. The raw Gaia data was filtered and narrowed down using Python analysis scripts obtained through the University of Virginia (UVA); selections were made on the membership of the cluster through looking at trends on the graphs it

produced. The selected data was used with an additional analysis script that calculated the following properties: average right ascension and declination, average velocity, rotational velocity, and tidal radius. Using the virial theorem and force balancing equation, the mass of NGC 6712 was found to be  $3.03 \times 10^4$  and 16 solar masses, respectively. A one-sample t-test was performed, yielding p-values of .38 for all data and .84 for binned data. Compared to an alpha value of .05, this revealed that the presence of rotation was not significant. The research hypothesis was supported, however, as it stated that if the membership of NGC 6712 was determined, the properties could be determined as well. This study shed light on the importance of star membership on the measurement of globular cluster qualities.

### **Studying Variables of Globular Cluster NGC 6304 Using Star Membership**

*Daniel Moon, Central Virginia Governor's School for Science & Technology*

The purpose of this project was to determine the rotational velocity, tidal radius, and mass of NGC 6304. This was done with Python scripts on data collected by the Gaia satellite. The scripts were used to analyze the cluster for observable variables, which include the magnitude, color, and star positions. The stars in the cluster were selected, ignoring background stars to get binned values. A tidal radius of 1.71 parsecs was found for NGC 6304. In addition, the mass of the cluster was found to be  $3.529 \times 10^4$  solar masses using the Virial Theorem, which contrasted with the Force Balance equation's calculated value of 1.808 solar masses. A rotational velocity of  $-.001 \pm .257$  mas/yr-1 with a p-value of .976 for all data values and .324 for binned values was obtained. Compared with an alpha value of .05, it was found that there was no significant rotational velocity within NGC 6304. This retained the null hypothesis, which stated that there would be a rotational velocity of zero. The research hypothesis, which stated that the properties of NGC 6304 could be found accurately was rejected.

### **A Comparison of Lunar Cratering Frequency Based on Latitude and Longitude**

*Mary O'Sullivan, Chesapeake Bay Governor's School for Marine & Environmental Science*

In the near future, NASA will be trying to send humans and technologies to outposts on the moon's surface. Mitigating risks to crew safety is of paramount importance for NASA in any mission in which humans are involved. One of these potential risks is meteoroid impacts. Therefore, this study looked at cratering frequency for different areas of the moon to determine if there was any correlation between cratering frequency and latitude/longitude of the moon. The alternate hypothesis for total frequency and frequency dependent on size were that the cratering frequency would increase closer to the poles and there would be more cratering on the side of the moon facing away from earth versus the side facing. The data was collected using a lunar survey called Moon Trek. Four random locations were chosen per latitude and longitude range. The craters inside that two-degree latitude field of view were counted on the application Paint using colored markers that served to also indicate size and the numbers were recorded. Two-way ANOVAs were run on the data for the total cratering frequency and for each of the three size ranges. The only significant relationship that was found in this study was that of longitude and crater frequency for medium sized craters, with the side away receiving



more impacts than the side facing. This knowledge could be used to make some conclusions on relative age of the surface and where to build lunar outposts.

### **The Effect of Drag Swimsuit Materials on the Speed of a Simulated Swimmer**

*Mallory Pham, Clover Hill High School*

### **The Effect of the Material of the Subfloor System Placed under Marley Matting on the Maximum Acceleration of a Dropped Mass (m/s<sup>2</sup>)**

*Katelyn Roberts, Clover Hill High School*

### **The Effect of Bat Composition on Rebound Height**

*Caiden Romero, Clover Hill High School*

### **The Effect of Metal on Resistance to a Vacuum**

*Arupava Saha, Mills E. Godwin High School*

The purpose of this study was to find whether steel or aluminum would be better able to resist vacuum pressures. Many metals have been used throughout history, but none have been more important in recent endeavors as steel and aluminum. Aluminum was used in the aerospace field since the Wright Brothers. Steel was one of the most commonly used metals, as more than one and a half billion tons of steel were used in 2017. By understanding which metals would be able to resist a simulation of space, it would show whether aluminum or steel would best resist the conditions in the outer layers of the atmosphere. That would help increase the safety and efficiency of air and space craft. It was hypothesized that if metals were tested on their ability to resist a vacuum, then aluminum would perform better due to its light weight and strength. The control was aluminum. Unopened steel and aluminum 355 mL soda cans were placed into a handmade vacuum chamber, which was made up of a chamber, pump, and various plumbing fittings. The mean and standard deviation for aluminum was -77.43 kPa and 5.674, while the mean and standard deviation for steel was -61.59 kPa and 2.802, respectively. It was concluded that the hypothesis was supported, and this was believed to be due to aluminum's greater strength at lower weights.

### **What Is the Effect of the Length of a Catapult Arm on How Far a Ping Pong Ball Is Launched?**

*Gabriel Sessions, Washington-Lee High School*

The goal of this experiment was to determine if the length of a catapult arm had an effect on the launch distance of a ping pong ball. Based on equations which convert rotational motion to linear motion and the equations of kinematics, it was hypothesized if the length of a catapult arm changed then the larger arms will launch ping pong balls further because these arms have a larger rotational velocity. To test the hypothesis, a catapult was bought and assembled, and ping pong balls were launched with four different sized arms: 10cm, 13cm, 16cm, and 19cm. Based on the data collected, the 10 cm arm had the lowest mean average distance launched and the 19 cm arm had the highest mean average distance. Based on a linear regression test, a positive trend was determined with a trendline with a slope of 0.127. Moreover, it was found that there was significant data between the 13cm and 16cm groups and the 16cm and 19cm groups based on an ANOVA test and T-Tests.

The resulting p-values were below 0.05 meaning the null hypothesis can be rejected. As a result of data analysis, it can be said that the hypothesis was supported by the data as the larger arms had longer launch distances. Additionally, the data matched the predicted values based off of kinematic equations and previous research which showed the data was reasonably accurate.

### **The Effect of Synthetic and Natural Fiber Materials on Sound Absorption**

*Mia Shenkman, Washington-Lee High School*

### **Studying Star Cluster NGC 6539**

*Taylor Tolbert, Central Virginia Governor's School for Science & Technology*

The purpose of this study was to determine the membership of the star cluster NGC 6539 and from that membership, determine properties about the cluster to see if there was rotation within it. This study was conducted using scripts and codes in the computer program Python. The data from the Gaia Space Telescope was run through a first set of scripts in order to determine the membership, then that data was run through a second set of scripts that ran a two-tailed one sample t-test. This test gave out a p-value of .504 for all of the data and .836 for the binned data. With an alpha value of .05, the null hypothesis, which stated that there was no rotation within the cluster, was retained. However, the research hypothesis that membership of the cluster and characteristics of that cluster would be found, was supported.

### **Simulation of Timescale Matching between Organic and Metallic Phase-change Materials for Transient Thermal Reduction**

*Justin Wang, Chantilly High School*

Most thermal reduction technology utilizing phase-change materials (PCMs) focuses on employing organic or metallic PCMs, but not both. This study reports a synergistic transient effect – timescale matching of organic and metallic PCMs – using the Army Research Laboratory's ParaPower. Four procedures were implemented. First, a convergence study of ARL ParaPower was conducted. Second, with ARL ParaPower's convergence ascertained, Monte Carlo simulations of a single-chip module with a flux of 350 W/cm<sup>2</sup> for 2.5 seconds were employed to gain insight using Pareto optimization. Third, manufacturing constraints and the insight obtained were applied to reduce the search space to find synergistic effects of organic and metallic PCMs on a single-chip module. Fourth, the insights gained were applied to a multi-chip module, using a flux of 120 W/cm<sup>2</sup> for 2.5 seconds, to further understand timescale matching of PCMs. The results show ARL ParaPower converges with first-order temporal and second-order spatial convergence. Of the three PCMs, Field's metal was eliminated for poor performance in timescale matching with other materials. Most importantly, superior timescale matching of metallic gallium and organic PureTemp29 has been confirmed in single- and multi-chip modules, which nearly quadruples the set of Pareto-optimal points with the greatest transient thermal reduction using PCMs.

### **The Effect of the Material Wound in Guitar Strings on the Length of Sustain on an Electric Guitar**

*Brett Zimmermann, Clover Hill High School*

## **Plant Sciences and Microbiology**

### **The Allelopathic Effect of *P. montana* Organs on the Germination of *L. esculentum***

*Merryn Isbell, Roanoke Valley Governor's School*

The purpose of this experiment was to better understand the allelopathic effect that *P. montana* organs would have on the germination *L. esculentum*. *P. montana* is an extremely invasive weed and can inhibit the growth of many other plants. Around Virginia and other southern states, *P. montana* is extremely common in many areas including road and the highway sides. In the United States alone, there are 1,158,306.4756 square kilometers of *P. montana*. This project could help to determine the exact effect each organ of *P. montana* has on *L. esculentum*. The growth of *L. esculentum*, a common garden plant in many southern gardens, could be at risk because of the rapid growth rate of *P. montana* which spreads up to 18.288 meters annually per plant. It was hypothesized that if a filtrate from the roots of *P. montana* is pipetted on the seeds of *L. esculentum*, then the filtrate would inhibit the growth of the *L. esculentum*. Each Petri dish was prepared by first placing MS10 medium into each dish. Next, each filtrate was made and 7 ml of each was added to the agar in the Petri dishes. Then, 10 seeds of *L. esculentum* were placed in each petri dish and set into a tray and put under constant light at approximately 25°C. The germination of each seed was recorded after 24, 48, and 120 hours. The data indicated that each day the *L. esculentum* seeds continued to germinate and further grow. However, the *P. montana* root filtrate inhibited the germination more than any other filtrate. A Chi-Squared test was run to determine the P-value of the collected data. An additional step was taken to measure the length of each radical, and the hypothesis was tested using the Welch's ANOVA. The test for all the germinated seeds showed that the P-value was 0.000001563424, meaning that the data suggests there was a significant difference between the germination of the seeds and their corresponding filtrate.

### **The Effect Of Container Material On The Growth Of Bacteria To Make Yogurt**

*Shreesh Kalagi, George H Moody Middle School*

Though study in the field of science is one of the largest careers in the world, there are many things that scientists have yet to discover. One of these being if container material had any effect on the growth of *Lactobacillus bulgaricus* and *Streptococcus thermophile* in an environment with milk. It had been previously researched that the growth of these bacteria in milk over time resulted in the production of yogurt. Even before this discovery was made, however, humans had been making yogurt for many centuries (Fisberg and Machado, 2015). Throughout the course of time, no one had really cared to wonder what container material is the most optimal for yogurt making, thus, why this experiment was conducted. The researcher hypothesized that because objects of steel own the quality of bacteria growth, that steel would yield the quickest results. After researching, as well as a few preparations, the experimenter conducted the experiment. Firstly, 1.65 L of milk was poured into a large container or vessel. The milk was then allowed twenty to thirty minutes to boil. Afterwards, 355 mL of the milk was evenly distributed into four containers of steel, glass, plastic, and porcelain. The milk was allowed six to eight hours to cool and

transform into yogurt (Rule, 2015). In between the six to eight-hour time frame, the experimenter tested pH strips every twenty minutes. After ten experiments had concluded, all of the data was collected and translated into graphs and charts, as well as verbally noted. The container that proved to work the best was the glass container, as it had the least timings overall. In second was plastic, in third was steel, and the container that worked the least was the porcelain. In conclusion, if it is desired to produce yogurt, the milk used should be allowed to cool in a glass container for the quickest results.

### **The Effect of Salinity on Cell Preservation**

*Aria Merrill, Thomas Jefferson Middle School*

The purpose of this study was to determine how the salinity of the liquid in which beetroot cells are frozen affects the integrity of beetroot cell membranes. The independent variable was salt. The experimental group included four different salinities; 5%, 10%, 15%, and 20% at average freezer temperature (-18°C). The control group was comprised of cells preserved in 0% salinity. The dependent variable was the amount of cells ruptured, as measured by the pigment released by the damaged beetroot cells. The constants were the jars used for storing the beet samples and salt solution, amount of solution, and mass of beetroot sample. The researcher hypothesized if a cell sample is placed in 20% salinity, then cells are less likely to rupture throughout the preservation process. To conduct this experiment, the researcher created solutions of 5 different salinities, 0%, 5%, 10%, 15%, and 20%. Three jars were allotted to each salinity to increase reliability. A beet sample was placed in each jar and placed into an environment of -18°C for 24 hours. Then, the researcher measured each jar's color using a colorimeter, converting the RGB values to HSV values and comparing the saturation percentage of each salinity. The results accepted the hypothesis, showing that the least number of cells ruptured while preserved in a solution of 20% salinity. In conclusion, the study suggests that higher salinities produce better outcomes when preserving cells.

### **The Effect of Volatile Organic Compounds Commonly Found in Urban Areas on the Health of Mexican Marigolds**

*Nabiha Islam, Thomas Jefferson Middle School*

The purpose of this study was to investigate the effects of different types of volatile chemicals (VOCs) that are commonly found in urban areas on the health of Mexican Marigolds (*Tagetes erecta*). The hypothesis was: If Mexican Marigolds were exposed to the gasoline and glass cleaner fumes, then their growth will be stunted. The independent variables were the different types of volatile chemical sources: glass cleaner, gasoline, and bananas. The dependent variables were the height and color of the marigolds in each group. The control group was made up of Marigolds receiving no specific volatile chemical sources. The constants were: the amount of potting mix, water, temperature, light, chemical exposure, and the type of water bottles. In the experiment, the marigolds were germinated on a wet paper towel in a plastic bag and were then transplanted into their own water bottle. The marigolds were exposed to the VOCs by cotton balls glued to the underside of each cap, which contained their designated scents in a liquid form. The marigolds received carbon dioxide for a twelve-hour period after every week, and the scents were renewed afterward. The results showed that the VOCs that are harmful to humans caused the plants to undergo negative changes and eventually die. These results

support the hypothesis because the Mexican Marigolds that were exposed to the gasoline and glass cleaner fumes experienced the least amount of growth. Overall, the study suggests that VOCs, which are detrimental to humans, are also harmful to the environment.

### **The Effect of Type of Aquatic Plant on Phosphate Absorption**

*Lewis Wearmouth, Thomas Jefferson Middle School*

The purpose of this study was to find which aquatic plants have the greatest phosphate absorption. The independent variable was the type of aquatic plant. The experimental group included Lizard Tail, Whorled Rosinweed, and Broadleaf Arrowhead. The control group was soil. The dependent variable was the amount of phosphates absorbed. The constants were the type of pot, the plastic container under the pots, the soil, the water, the amount of water, the phosphate-water mixture, and the environment. The hypothesis was: If different aquatic plants are watered with a phosphate-water mixture, then Lizard Tail will absorb the most phosphates out of the mixture. Six aquatic plants and two pots of soil were left in a plastic container with the phosphate-water mixture. After three days, the researcher came back and watered the experimental group with 0.1 liters of plain tap water. After 10 minutes, the water at the bottom of each container was tested for its phosphate level. Then, the researcher poured out all the excess water in the container. This procedure was repeated four more times, for a total of five trials. The results showed that Lizard Tail was the best absorber of phosphates out of the experimental group. These results supported the hypothesis. In conclusion, the study suggests that Lizard Tail is a useful plant for removing excess levels of phosphates and nitrates from bodies of water.

### **The Effect of Type of Surfactant in a Shampoo on the Growth of Marigolds**

*Ellie Rowland, Thomas Jefferson Middle School*

The purpose of this study was to test the effects of the type of surfactant in shampoo on the growth of marigold plants. The independent variable was the type of surfactants in the shampoo. The experimental group included four groups: two with biosurfactants (Dr. Organic Virgin Coconut Oil and Avalon Organics Nourishing Lavender shampoo); two with petroleum-based surfactant (Pantene Classic Clean and Dove Daily Moisture shampoo). The control group included marigolds that were not given shampoo; they were given water. The dependent variable was the mass of the marigold plant. The constants were the type of plant, the amount of water given to each plant, the amount of shampoo given to each plant, the amount of sunlight, and the time of day each plant was watered. The hypothesis was: If a marigold plant is given shampoo containing biosurfactants, then that plant will gain more mass than plants given shampoo containing petroleum surfactants. Fifty marigold seeds were separated into five equal groups, planted, and watered for seven days. The plants were weighed, and for the next seven days, they were watered with solutions containing their respective shampoos. At the end of the growing period, the plants were weighed a second time. The results showed that all surfactants, biodegradable or petroleum-based, prevented marigold plants from growing, and marigold plants grew the most when given water. These results do not support the hypothesis. In conclusion, the study suggests that all shampoo, whether it contains biodegradable or petroleum-based surfactants, is harmful to plants.

## **The Effect of Additional Nutrients on Algae Biomass**

*Amelia Sahn, Thomas Jefferson Middle School*

The purpose of this study was to determine whether nutrients increase microalgae growth. The independent variable was the nutrients (culture salts and liquid nutrients). The liquid nutrient F/2 which was used in the experiment, was perfected from a formulation created by Guillard and Ryther. The control group was algae without nutrients. The dependent variable was algae biomass, measured by the depth at which the secchi stick was visible when inserted in the algae. The constants were the culture tube, strain of algae, and light source. The hypothesis was: Algae with added culture salts and liquid nutrients will grow more than algae without any added nutrients. This study is important because it will allow scientists to understand the role of nutrients in growing algae biomass. Culture tubes were arranged in a 3x3 formation under a light. The culture tubes were filled with 50 mL of water, and 2 mL of algae, with the addition of nutrients in the IV trial. Each trial had a duration of ten days. The results showed that the addition of nutrients (culture salts and liquid nutrients) increases algae biomass. The hypothesis was accepted. In conclusion, the study suggests that adding nutrients (culture salts and liquid nutrients) increases algae biomass.

## **The Effect of Mycorrhizal Fungi on the; Pigmentation, Height, and Amount of Water in the Leaves of the Oregon Snow Pea**

*Eleanor Gookin, Thomas Jefferson Middle School*

The purpose of this study was to find out how mycorrhizal fungi affected plant growth. The independent variable was the amount of mycorrhizal fungi present in soil. The experimental group included the plants with mycorrhizal fungi present in the soil. The control group was the plants without mycorrhizal fungi. The dependent variables were the pigmentation, height, and amount of water in the leaves of the plants. The constants were: the plant type, the container type, the soil type, the soil amount, the laboratory equipment used, the temperature of the room, and the amount of water and sunlight given to the plants. The hypothesis was: If plants are planted with mycorrhizal fungi present in the soil, then they will grow higher, have a higher pigmentation, and have a larger amount of water in their leaves than plants without mycorrhizal fungi present. This study was important because if mycorrhizal relationships help plants produce more food, then more food can be spread to areas of the world where starvation is a problem. Snow peas were planted with and without mycorrhizal fungi present in the soil. They were allowed to grow for 24 days. After this time, the height, pigmentation, and amount of water in the leaves of the plants were measured. The results showed that mycorrhizal fungi appeared to have no effect on the height, pigmentation, and amount of water in the leaves of snow peas. It might, however, have a greater difference in different factors that were not measured, such as root mass, or even have a greater contrast between the two groups in the factors measured over a greater amount of time, especially in height. These results rejected the hypothesis. In conclusion, the study suggested that mycorrhizal fungi appeared to have no effect on the; pigmentation, height, and amount of water in the leaves of the Oregon Snow Pea.

## **The Allelopathic Effect of *B. oleracea italica* on the Germination of *B. oleracea botrytis***

*Ella Bryant, Roanoke Valley Governor's School*

Agriculture is an essential component for every civilization that entails proper crop rotation and companion planting. Crop rotation is the annual location transfer of crops, and companion planting is the process of pairing plants with those that benefit one another. For these processes, the knowledge of whether *B. oleracea italica* (broccoli) has allelopathic effects on *B. oleracea botrytis* (cauliflower) germination is important. Allelopathy is the effect of a plant on another plant by the release of allelochemicals. It was hypothesized that the allelochemicals in *B. oleracea italica* would inhibit the *B. oleracea botrytis*'s germination. In this experiment, the independent variable was *B. oleracea italica*; it had four concentration groups: 0%, 30%, 60%, and 100%. The dependent variable was *B. oleracea botrytis*. Both the germination, as indicated by when the radicle became visible, and radicle length were measured. 10 milliliters of solution were placed in each petri dish along with MS10 medium. There were 40 petri dishes with 10 trials per solution concentration. The germinated seeds were counted after 24, 48, and 144 hours. A Chi-Square Test was run for each time the germination was recorded. For the 24, 48, and 144 hours, all the p-values were less than the alpha value of 0.05 (p-values were  $1.2731 \times 10^{-12}$ ,  $7.1253 \times 10^{-8}$ , and  $4.3445 \times 10^{-8}$  respectively). The p-value for the radicle lengths was less than 0.0001. Since each p-value is lower than the alpha value (0.05), there is a relation between the *B. oleracea italica* solution concentration to the development of *B. oleracea botrytis*. The averages of each radicle length decreased as the concentration increased. Therefore, the results support the hypothesis. This information will help the profit and productivity of farms with cauliflower.

### **Does Magnetizing *Raphanus Sativus* Seeds Multiply Crop Yield?**

*Shreya Madan, Hidden Valley Middle School*

As global demand of agricultural crops for food and fuel increases, magnetic field exposure may provide a feasible solution for bio-stimulation of seeds in agriculture. The primary objective of my project is to study the effects of different magnetic field strengths on radish seed germination, plant growth and yield. The project was conducted in two phases. Phase one was conducted by placing seeds in three containers: control with no magnet, one with a weaker, and one with a stronger magnet. The seed germination rate and radicle length was measured on the fifth day in all three groups. Magnetized seedlings were planted in phase two in pots. Phase two assessed plant growth and the mass of radish roots at the end of six weeks. The average germination rate was 90.8% in the high magnet group, 78.4% in the low magnet group, and 59.6% in the control group. The radicle length was 82.2mm in the high magnet group, 62mm in the low magnet group, and 55.8mm in the control group. Phase two results showed the average mass of the radish root was 5.8gms, 4gms, 3.6gms in the high, low, and control groups respectively. Magnetized seeds germinated faster and at a higher rate than the controls. Radicle length was longer for magnetized seedlings and roots of magnetized plants had higher mass. Magnetism can be a safe, eco-friendly method to enhance crop yield without chemical exposure. Future research to explore the effects of varying magnetic fields on different crops is crucial.

### **The Effect of Different Essential Oils on the Growth of Oral Bacteria**

*Isabella Sun, George H. Moody Middle School*

The human mouth has been estimated to host more than 600 types of bacteria. Most of these do nothing to affect human health, but there are exceptions; some are beneficial, and others are extremely harmful. There has been a growing interest in making natural mouthwash to kill certain bacteria with natural ingredients, which would be less harmful than the usual alcohol that is used. The purpose of this project was to determine how cinnamon, clove bud, peppermint, tea tree, rosemary, and lemon essential oil would affect the growth of oral bacteria. Circles cut from paper towels were soaked with 50  $\mu$ l of each variable and placed in the agar plates, which were then sealed with clear Scotch tape and stored in a small room for 24 hours. When the inhibition zones of the essential oils were tested against that of the negative control, all the p values were less than 0.05, suggesting that the differences were statistically significant. When the inhibition zones of the essential oils were tested against that of the positive control, all the p values were also less than 0.05, confirming the differences were also statistically significant. The data supported the research hypothesis that if oral bacteria is treated with essential oils, then the zone of inhibition of oral bacteria growth will be seen.

### **The Effect of Duration of UV-A Exposure of Growth of *Ocimum basilicum***

*Gwyneth Liu, George H. Moody Middle School*

*Ocimum basilicum*, also known as basil, is an herb that is known for being simple to grow. Basil plants are recommended to receive 6 hours of sunlight per day. Sunlight contains multiple types of UV light, including UV-A, UV-B, and UV-C. UV-A is the most abundant among the three. Unlike UV-B, UV-A does not damage DNA in cells, though prolonged exposure is still unhealthy towards plants. UV light has been proven to help plants produce proteins, antioxidants, and flavonoids that protect the plant against UV overexposure. The purpose of this experiment was to find the proper duration of UV-A exposure for basil growth. Five groups of 12 plants were exposed to 4, 6, 8, 10, and 12 hours of UV-A light. The group exposed to 6 hours of light was the control group. After a 12-day germination period and a 4-week growth period, each plant's height was measured in centimeters. The mean height of each group was computed. The data showed that the plants that grew the tallest were in the group exposed to 12 hours of light (5.5 cm) with a positive correlation between the height of the plants and the duration of exposure. The data did not support the hypothesis that the 8-hour group would have the greatest growth. Based on the data, the longer the exposure to UV-A light, the taller the plant grew. This was most likely because the light provided more energy and nutrients to the plant without damaging the cells. A more accurate experiment can be conducted by creating a reservoir or giving a proportional amount of water instead of a constant amount. This would eliminate the impact of water on the experiment. More levels could have been added to study if there is a point where the growth will drop.

### **The Effect of Different Concentrations of Triacantanol on the Height of *Raphanus sativus* Sprouts**

*Laasya Konidala, George H. Moody Middle School*

Triacantanol is a growth stimulant for plants that helps regulate different enzymatic activities and increase photosynthetic rates. The purpose of this experiment was to explore how triacantanol affects *Raphanus sativus* plant height through foliar application at concentrations of 0 PPM, 0.5 PPM, 1.0 PPM, 1.5 PPM, and 2.0 PPM. It was



hypothesized that the 1.0 PPM solution will yield the tallest plant because several prior studies suggest that this concentration had the greatest visible effect on plants in terms of stem height, chlorophyll content, the number of leaves, length of leaves, and diameter of stems. However, the effects can expand past visuals to include increases in nutrient content, amino acids, enzymatic activities, photosynthesis, and protein synthesis. For each level, 0.2 grams of 90% TRIA was dissolved into Polysorbate-20 and was then added to a liter of water. Five milliliters of this solution were taken to dilute in another liter of water, and the amount of solution to be taken to even further reduce the concentration was altered between levels. Fifty radish seeds were planted, and stressed groups were sprayed with their triacontanol solutions twice a week. The results concluded that TRIA induced an increase in plant height compared to the control. The hypothesis was supported that Group C would have the tallest sprout (6.25 cm.) The null hypothesis was rejected, and the t-test performed indicated a significant difference between the averages of the levels ( $t = 5.473 > 2.101$ ;  $t = 10.102 > 2.101$ ;  $t = 4.927 > 2.101$ ;  $t = 4.821 > 2.101$  at  $\alpha = 0.05$  and  $df = 18$ .) The results agree with findings of other researchers that TRIA enhances growth and it does so best at a 1.0 PPM concentration.

### **The Effect of the Duration of Cryopreservation on the Germination of Seeds**

*Shreya Shanmugan, George H. Moody Middle School*

In recent events, nuclear bombs and artillery have become a real threat due to the many creations and even the possession of these weapons. Nuclear weaponry is very detrimental to the earth and the many environments in which most living beings depend on for survival. Even the slightest amount of nuclear waste can spread and ruin miles and miles of land. Furthermore, many sources for the creation of food come from harvested plants and crops, as well as animals. In addition to the miles of land being destroyed, the source of food will also be destroyed as well. The purpose of this experiment was to find a quick and also effective duration in which seeds need to be cryopreserved in order to germinate at a quicker pace. The hypothesis created for this experiment was if the seeds are cryopreserved for ten days then the germination of the seed will be faster. During the experiment, there were five groups of independent variables, the seeds that were preserved for one day, the seeds that were preserved for two days, the seeds that were preserved for five days, the seeds that were preserved for ten days and the control group where the seeds were not preserved at all. Then these seeds were observed for about three weeks while they were germinating, and the data was collected and recorded. The results showed that the average length of the sprouts after germination for the control group was 0.54 cm, the average length of sprouts for the preservation of one day was 0.70 cm, the average length of sprouts for the preservation of two days was 0.84 cm, the average length of sprouts for the preservation of five days was 1.14, and the average length of the preservation of ten days was 1.96. Based off of this data, the research hypothesis was supported as well as the fact that the longer a seed is cryopreserved, the quicker the germination of the seed will be.

### **The Effect of the pH of Water on the Height of *Alliaria Petiolata***

*Mara Gerardi, Williamsburg Middle School*

The purpose of this experiment was to test how the pH of water affected the growth of *Alliaria petiolata*. The hypothesis stated if *Alliaria petiolata* was watered with the alkaline

solution, then the height would be greater than if they were watered with the acidic solution because the success of the plant, as measured by plant dry weight, have been found to be greater in less acidic soil, and *Alliaria petiolata* also increases the pH of the soil around it to a higher and or neutral range. The independent variable was the pH of the water and the dependent variable was the height of the plant. Ten *Alliaria petiolata* plants were separated into two groups of five plants. One group was watered with an acidic solution (pH of 4.0-5.0), while the other group was watered with an alkaline solution (pH of 9.0-10.0). One separate plant, used as the control, was watered with water that had a neutral pH of 7.0. The hypothesis was rejected. The average height of the acidic solution plants (7.68 cm) had an increase over the alkaline solution plants (6.64 cm). This experiment can help further the knowledge of the effect of soil components on the growth of invasive species. Future experimentation could involve testing the effect of the acidic solution on the growth of different types of invasive plants. This could be linked to how acid rain impacts the non-native plants.

### **The Effect of Type of Vinegar on Zone of Inhibition**

*Charlotte Papacosma, Gunston Middle School*

The purpose of the experiment 'The Effect of Type of Vinegar on Zone of Inhibition' is to determine which of six types of vinegar is most effective in preventing the growth of common bacteria such as *E. coli*. A zone of inhibition is the area around an antimicrobial agent that is completely clear of bacteria. When conducting the experiment, five Petri dishes (for five trials) were first filled with a liquid agar and left to harden, and then swabbed with a K-12 strain of *E. coli* bacteria so as to cover the entire surface of the agar. The dishes were divided into sevenths, and cardstock circles ('chips') were soaked in each type of vinegar and the control (water) and applied one per section. The dishes were incubated for 48 hours, and once removed, the zones of inhibition around each chip were measured to determine the effectiveness of each vinegar as an antimicrobial agent. The results determined that the most effective vinegar was the white wine vinegar. It was also discovered that the effectiveness of a vinegar is directly related to the vinegar's acidity percentage. This is because the acetic acid in vinegar is the ingredient that causes bacteria to die and creates the zone of inhibition. Future repetitions of this experiment may be improved by using only non-pigmented vinegars, as in this experiment, the exact zone of inhibition widths was impossible to determine with the pigmented balsamic vinegar.

### **The Effect of Method of Cleaning Sponge on the Number of Bacteria Colonies Remaining**

*Phillip Johnson, Williamsburg Middle School*

Sponges are a common household item for many people. However, for some people, they are believed to be a very unclean and full of bacteria cleaning device. This experiment was designed to find an efficient method for cleaning a sponge, in hope that more people would use sponges for longer periods of time rather than throw them away as quickly. The hypothesis for this experiment stated that if a microwave was used to clean the sponge then it would kill the most number of bacteria because of the heat and radiation from the microwave. The different methods of cleaning sponges included using

a microwave, putting the sponge in a bleach solution, soaking it in vinegar, and in the dishwasher. The control for this experiment was an uncleaned sponge. To collect the method of cleaning of sponge was done to a dirty sponge, then the sponges were swabbed using cotton swabs and put the swab with the bacteria on nutrient agar. After three days the bacteria colonies present were counted. In the end, the hypothesis was not supported. The method which was the most efficient was using a bleach solution. It was concluded that using certain sanitizing liquids is the most efficient because of the sponge's ability to absorb liquids. In this project, there were some errors but none that affected the data extensively. There are many ways to extend this project. After this experiment, it was evident that there are several effective ways to clean sponges and minimize bacteria growth.

### **The Effect of the Levels of Soil pH on the Growth Rate of *Phaseolus lunatus***

*Nazeed Habib, George H. Moody Middle School*

The pH of soil is correlated with the growth of a plant. Minerals and nutrients are vital elements in the growth of a plant and the pH of the soil mainly affects the availability of those minerals and nutrients to the plant. Minerals and nutrients are more soluble in slightly acidic soils than in neutral and slightly alkaline soils, therefore making minerals and nutrients more available in the soil since minerals and nutrients must be dissolved within the soil solution prior to being absorbed by the plant. The purpose of this project was to identify which soil pH level was the best for growing *Phaseolus lunatus* plants. The different soil pH levels used in this experiment were pH levels of 6.25, 4.11, 5.01, 5.39, and 5.11. The hypothesis was that if the soil pH level was 6.25, then the plants growing in that soil would experience the highest growth rate. The soil pH levels were adjusted accordingly using aluminum sulfate and lime, and after the adjustment of the pH levels the *Phaseolus lunatus* plants were planted. The plants would then be grown for a 30-day period. The growth rate of the plants (cm per day) was measured to identify the impact of the soil pH level on the growth of *Phaseolus lunatus* plants. The results of this experiment indicated that the plants grown in the soil with a pH of 6.25 (control group) had a mean growth rate of 0.43 cm per day, while the other plants experienced no growth. This experiment is inconclusive because there were probably many external factors involved in getting the results that were found. *Phaseolus lunatus* plants were planted only two days after the adjustment of the soil pH levels, when the planting should've been delayed another two weeks. Also, the pH meter could've been inaccurate. If the planting of *Phaseolus lunatus* plants was done two weeks after the application of aluminum sulfate and lime to the soil and a more accurate pH meter was used, then conclusive results could've been reached.

### **Turn That Ground Upside Down!**

*Maggie MacMullen, Swanson Middle School*

Upside down gardening has recently become a more popular style of gardening. Although uncommon, this technique could save space, prevent weeds, pests, and molds, and eliminate the need for herbicides and pesticides, rivaling traditional methods of gardening. The purpose of this project was to analyze how efficient upside-down gardening could be, compared to traditional, right-side-up gardening. In this experiment, "Turn that Ground Upside Down", the effect of the angle of plants was tested on their height. This project

was conducted with three levels of the independent variable (the angle of the plants) - plants grown at a 0degree angle, plants grown at a 90degree angle, and plants grown at a 180degree angle. It was hypothesized that the upside down (180 degree angled) plants would grow to be the tallest, because of the many beneficial factors that could contribute to its overall growth. Firstly, the upside-down plants' possible lack of weeds, pests, and mold could contribute to its health. Secondly, the upside-down plants could possibly grow more quickly because of their flipped gravitational pull. The nutrients and water in the soil might travel more quickly to the plant's stem and leaves because of the reversed gravitational pull, leading the plant to develop more quickly photosynthetically. Lastly, because the angle of the plants could affect their geotropism, or gravitropism, the plants might grow more quickly than right side up ones to reach their natural, upright position. To test this hypothesis, Snowbird Pea plants were grown from seed in an upright manner until they germinated. They were then split into three levels (or angles) and grown and recorded over a period of two months. It was found that the upside-down plants had, in fact, grown less than the sideways and right side up plants, with an average height of only 4.09 centimeters, compared to an average of 8.17 centimeters for the 90degree plants, and an average of 8.85 cm for the control.

### **The Effects of Dyes Added to Mycelium on Mushroom Color**

*Finn Holland, Sabot at Stony Point*

Humans have polluted the planet, and we need better ways to decontaminate soil and water. Mushrooms have been shown to be useful for this purpose, but more information is needed about how various species of mushrooms take up different toxins from the soil. This experiment was conducted to investigate whether or not the color of blue oyster mushrooms was changed when food coloring was added to the mycelium in order to investigate how much blue oyster mushrooms take up soluble materials from their growing environment. Red and green dyes were injected into the mycelium of four blue oyster mushroom kits. Seven days later, samples of mushrooms from each kit were harvested, and their color, in terms of percent CMYK, was measured using the SpeakColor app. Results were graphed and compared to determine if the color of the mushrooms that grew from the mycelium that had dye added was different from the control, which had no dye added. The results were inconclusive because, although there were differences in the color of mushrooms, there was not a clear pattern, and other variables may have affected the color.

## **Psychology A**

### **The Effect of Priming on Risk Perception**

*Naomi Abramowicz and Rachel Brill, Washington-Lee High School*

The purpose of this experiment was to determine whether priming using visuals affects risk assessment among adolescents. It was hypothesized that those who watched videos of faster cars would rate scenarios as riskier compared to those who were not primed with any video content or who were primed with a video of slow-moving cars because of the existing association between speed and risk. Ninety-six participants equally divided into three groups: control group, slow car group, and fast car group. The slow car group was

shown a video of cars in traffic and the fast car group was shown a video of race cars at high speeds. All the participants took a survey after watching the video asking them to rate different scenarios based on their level of risk on a scale of 1-5. The hypothesis was overall not supported by an ANOVA test that evaluated the differences between the three levels. Further ANOVA tests evaluating the differences between individual questions found that two of the twelve questions had statistically significant results. The three groups were extremely close in mean value. However, 9 out of 12 questions had a greater means for the fast car group than for the slow car group. Due to these results, the null hypothesis stating that there would be no significant difference between the groups cannot be rejected.

### **The Impact of Financial Experiences and the VA EPF Course on Financial Literacy among Teenagers**

*Colin Berry, Yorktown High School*

The goal of this experiment was to test how different factors affect the financial literacy of high school students. Financial literacy is a very important part of education because it prepares students for college and living on their own. The hypotheses were that the Virginia state required Economics and Personal Finance (EPF) course, a credit card, and a paying job would all have a positive impact on financial literacy. It was also predicted that personal experiences with credit cards and jobs would increase the positive effect of the EPF course. The results were not what was expected - the data showed differences in the opposite direction of what was hypothesized for the EPF course and the credit card moderator. Although not hypothesized, the data revealed similar differences across gender that have been found in prior studies, with females scoring worse than males. While the sample size is too small to make reliable conclusions (with a sample size of 30 students and a 6% response rate), the lack of significant positive effects from the Economics and Personal Finance course across the three financial literacy questions on interest rates, inflation, and risk diversification suggest that a larger Yorktown-sponsored survey might be a useful activity. The results also suggest that attention to gender differences is necessary, with a focus on reversing these differences.

### **The Effect of Age on Perception of Time**

*Ava Boston, Yorktown High School*

The purpose of the experiment is to determine how individuals' experiences with time perception differ due to age. My hypothesis states: as age increases, people will perceive time as passing faster. I created a survey with four questions: How quickly do you think the past week, month, year, and decade have gone by on a scale of 1-5 with 5 being fastest? I timed the interview and asked participants how long they thought it was in seconds. My hypothesis was accepted; participants in the 60+ age group perceived time as passing the fastest compared to all other age groups. The 18 underage group perceived time as passing the slowest. According to this experiment, there is no statistical correlation between age and short-term time perception. Participants in the 20's and 30's age group on average got the lowest difference between perceived time and actual time; they guessed durations of short-term time periods most accurately. A scientific explanation for the results is how the brain processes information. When the brain collects familiar information, it takes less time to organize it. New information requires more

processing, which makes it feel longer. Therefore, new experiences seem longer than routine ones. Since younger individuals have more new experiences, they perceive time as passing slower than older individuals who have had those experiences and have more routine schedules. The results are relevant because it contributes to our knowledge of the human brain and how individuals experience different perceptions of time due to age.

### **The Effect of Music on the Reading Comprehension Abilities of High School Students**

*Madison Clarke, Chesapeake Bay Governor's School for Marine & Environmental Science*

Music has become an integral part of student life. However, a widely accepted view on this topic is that environmental distractors negatively impact students' learning and performance by taking the focus away from the main task. The Mozart Effect is a theory hypothesizing that individuals who listened to Mozart's classical sonatas would have enhanced spatial intelligence. Under the idea that an increase in music "complexity" would act as a greater distraction, it was hypothesized in this study that higher scores and faster completion times would be achieved when a test was taken in silence. Scores would lower and times would increase while tests were taken listening to classical music followed by students' choice of music. A total of 108 participants were divided into groups based on the school the students attended: 60 students from a regional Governor's School and 48 students from a public high school. In statistical testing, there was a significant difference in scores for all groups. All students and high school students scored best in silence followed by classical music and then their choice of music. This was not true for Governor's School students, however, who scored best with classical music. All groups took the least amount of time while testing with classical music. Statistical tests showed significance for the all student group and Governor's School but not for general high school students. Overall trends showed that students performed the worst when listening to their own choice of music and Governor's School students may experience a Mozart Effect due to critical thinking skills.

### **The High Activity Allele of MAOA's Association with Nervous Habitual Behavior Not Linked to a Disorder**

*Audrey DeCosta, Southwest Virginia Governor's School*

### **The Effect of Religious Involvement as a Teenager on Major Life Decisions**

*Bailey Duncan, Central Virginia Governor's School for Science & Technology*

The purpose of this study was to examine if there is a correlation between religious involvement as a teenager and major life decisions made later in life. This study was conducted with the help of staff from a local high school along with local government employees during November of 2018. All participants were sent an email with a survey, in which they were asked questions about their life decisions, such as career, education, and family. They were also asked about their religious participation as both an adult and a teenager. Each answer was assigned a numerical value in order to run multiple tests for linear regression with an alpha value set at .05. Out of the 11 tests, only two produced p-values lower than .05. The relationship between religious involvement as a teenager and an adult had a p-value of .04, and the relationship between religious involvement as

a teenager and the influence of education had a p-value of .03. This information was not sufficient to support the research hypothesis that religious involvement as a teenager had an effect on major life decisions; therefore, the hypothesis was not supported. In conclusion, religious involvement as a teenager does not have an effect on major life decisions.

### **The Effect of Cellular Devices on Student Performance**

*ThanhLong Duong, Mills E. Godwin High School*

Students argue that cell phones do not distract them enough or at all in order for them to affect the students' performance in school, while professors, teachers, and parents argue otherwise. This experiment was conducted to explore the effects of a cellular device on a student's performance on an assessment. It was hypothesized that the use of cell phones would decrease the student's performance on the assessment. Twenty participants were assessed, all juniors or seniors gathered from local high schools. Two assessments were given to each subject: on the first, the subject did not have access to their cell phone; on the second, the subject was asked to respond to five text messages sent in thirty second intervals while they were taking the assessment. On each assessment, there were twelve main questions with unique point values based on their difficulty ranked by the researcher. There was also one hidden question to assess the subject's attention to detail. Each assessment had a time limit of three minutes. The number of correct questions and points accumulated, and if the hidden question was passed or failed were recorded. The difference between the two assessments was also recorded, where a positive difference correlated to better performance on the first assessment and a negative difference to better performance on the second. Generally, performance on the first assessment was better than on the second. The two assessments were statistically compared to each other, and the difference was statistically compared to a null difference, where another data set was created with each point as zero, representing the null hypothesis, which stated that there would be no difference between the two assessments. It was found that there was no statistical significance between the assessments, which could be due to failure to keep constant the testing environments for each subject, biasing in question difficulty, or simply too small of a sample size.

### **The Effect of Color on Short-term Memory Retention**

*Ronojoy Dutta, Deep Run High School*

### **Effect of Meditation on Overall Anxiety of High School Students**

*Meah Ellis, Central Virginia Governor's School for Science & Technology*

### **The Effect of Extraversion on Emotive Perception**

*Emma Farney, Mills E. Godwin High School*

### **Does the Self-reference Effect Extend to Handwriting?**

*Sophie Finkelstein and Alissa Rivero, Washington-Lee High School*

The purpose of the experiment was to determine whether the principles of the self-reference effect would extend to handwriting. This was tested by having participants read a passage in the font Times New Roman (Group 1), the font of a third party (Group 2), or

a font derived from their own handwriting, (Group 3). They were given a test to measure how well they had retained the information. The experimental hypothesis stated that participants who read the passage in the font derived from their own handwriting would have higher test scores than those who read the passage in the other fonts, due to the self-reference effect. It was supported by the results. Participants in Group 1 had an average score of 6.47 out of 10. Similarly, participants in Group 2 had an average score of 6.57 out of 10. On the other hand, Group 3 had an average score of 8.00 out of 10. In statistical tests, these results were used to determine that there was no significant difference between Group 1 and Group 2. However, the overall results were significant. This showed that there is little to no difference between reading a passage in Times New Roman and the third party's font, highlighting the influence of the self-reference effect, which did extend to handwriting. This can be seen as the participants in Group 3 generally had higher test scores than participants in the other groups.

### **Assumptions of Gender and Sexuality Based on Appearance**

*Shelby Hewes, Chesapeake Bay Governor's School for Marine & Environmental Science*

The purpose of this experiment was to see if a person's gender and sexuality can be correctly assumed based on appearance, if males or females are better at assuming gender and sexuality, if gender is easier to assume than sexuality, and if non-straight participants can assume better than straight participants. The data was collected using a Google form showing pictures of individuals and then asking two questions, "What do you believe the person above identifies their gender as?" and "What do you believe the person above identifies their sexuality as?". The results of the study determined males and females are equally poor at assuming gender and sexuality, gender is two-and-a-half times easier to assume than sexuality, and non-straight individuals are better at assuming sexuality but no better than straight individuals at assuming gender. In conclusion, assuming gender and sexuality of another is prone to error.

### **The Effect of Social Influence on Confirmation Bias**

*Ian Hodsdon-McGuire, Central Virginia Governor's School for Science & Technology*

This purpose of this study was to determine the effects of social influence on confirmation bias. The data was collected by surveying various participants at a local high school. Each participant would rate their opinion on the issue of social media censorship, using a scale of 1-10 provided, before and after reading an essay. The essay either had comments on it that were neutral to the participants' opinion, or supportive. Their mean change in opinion was calculated by subtracting their final response from the initial. The mean change in opinion was .4 for the neutral group and .5 for the confirming group, indicating that the comments had little effect on the participant's opinion. Performing a two-sample t-test showed that the comment type had no effect on the participant's opinion, producing a p-value of .4 ( $\alpha=.05$ ). Therefore, the research hypothesis that "If someone is presented with information that confirms their opinion in a social context, then they will strengthen that opinion," was not supported. Essentially, the social influences presented to the participant had no effect on their opinions and confirmation bias.

### **Detecting Correlation between Need for Cognition and Moral Development**



*Aidan Horton, Central Virginia Governor's School for Science & Technology*

The purpose of this study was to detect a correlation between need for cognition (NFC) and moral development. This study was conducted through surveys sent via email to each participant during December 2018. Students from local high schools and colleges completed a survey with two sections, one to determine their NFC score and another to determine their "moral score". The score for the NFC section was determined using a scale created by Cacioppo, Petty, and Kao, while the "moral score" was based off of Kohlberg's theory of moral development. The final R-value was .13. A regression analysis, with an alpha value set at .05, revealed the p-value was .473. This statistically insignificant value did not support the research hypothesis that NFC correlated with moral development. In summation, an individual's need for cognition does not correlate with their moral development according to Kohlberg's theory.

### **Does the Virginia 365 Project Have a Positive Impact on Virginia Elementary School Students?**

*Alicia Hundley, Southwest Virginia Governor's School*

Hunger has become increasingly prominent in the United States especially in elementary school aged children. The United States has been looking for a solution to decrease hunger within in their citizenships especially in younger children. The Virginia 365 Project is an attempt made by the Virginia state government to combat hunger. The program offers free breakfast, lunch, and third meal to elementary school students. The researcher's question is, Does the Virginia 365 project have a positive impact on Virginia elementary school students? In other words, does a program that kids of elementary school age free breakfast, lunch, and third meal have a positive impact on their lives. Impacts such as an increase in students' ability to focus, an increase in grades and test scores, a more positive outlook on school and life, and if they are going hungry less often than before. My results show that the Virginia 365 Project has had a positive impact on students' lives according to elementary school teachers. This means this project could help many children across the U.S. and the world and is something that should be implemented in every school nationwide and globally.

### **The Effect of Kawaii Aesthetic on Attention to Detail**

*Leah Karush, Washington-Lee High School*

The main purpose of this experiment was to determine if kawaii aesthetic, or cuteness, would affect the performance of people in simple, immediate, tasks, measured in both time and how carefully the task was performed. The other purpose was to determine if gender as well would affect the correlation between kawaii aesthetic and the performance of people in the same simple tasks. The first hypothesis was: If people are shown a picture of a cute baby animal, then they will perform a small manual task better than people who are shown a picture of an adult animal, because studies show that when humans see an animal baby, they involuntarily try harder and are more careful with the task. The second hypothesis was: If cuteness affects the performance of small tasks, then females would be more affected than males because they have a "maternal instinct," which would be triggered and would involuntarily cause them to put more effort into the task. There were 90 participants in total and all participants were chosen at random. Participants were shown either a picture of a cute puppy, a picture of an adult lizard, or no picture at all.

Then, participants were asked to cut out a sugar maple leaf while being timed. Data was analyzed based on the time taken to cut out the leaf in seconds and how carefully the leaf was cut out using a Likert scale. The data showed a statistically significant difference in both how well the leaf was cut out and also how long the participant took to cut out the leaf. The data collected on the effect of gender was not significant.

### **The Effect of Different Human Attributes on Eyewitness Identification Accuracy**

*Emily Lionberger, Mills E. Godwin High School*

Eyewitness identification has been used in criminal law but recently it has been proven that many identifications are inaccurate. The purpose was to research if different human attributes had a higher or lower chance of misidentification. A hypothesis was created stating if ethnicity, hair color, the presence of facial hair, and the presence of tattoos were tested for eyewitness identification accuracy, then ethnicity would be the most accurate. There was no control because there is no human attribute that is constant in every face. A video was obtained, and a four-question quiz was created based on the video. After participants silently watched the video, they were given five minutes to complete the quiz. The quizzes were graded with questions worth one point that would be totaled into an accurate/inaccurate percentage. The results concluded that ethnicity, hair color, and the presence of facial hair were all mostly accurate while the presence of tattoos was mostly inaccurate. A chi-square test indicated that the presence of facial hair ( $\chi^2 = 36.0 > 6.635$ ) and the presence of tattoos ( $\chi^2 = 36.0 > 6.635$ ) were both significant (at  $\alpha=0.01$  and  $df=1$ ). When ethnicity ( $\chi^2 = 1.0 < 6.635$ ) and hair color ( $\chi^2 = 4.0 < 6.635$ ) were calculated for a chi-square value, both were insignificant (at  $\alpha=0.01$  and  $df=1$ ). Based on the varying accurate/inaccurate rates, it can be concluded that facial hair is most likely, hair color and ethnicity are less likely, and tattoos are very unlikely to be accurately identified by an eyewitness.

### **The Correlation between Students' Academic Performance in Elementary School and Their Academic Performance in High School**

*Cecelia MacNamara, Chesapeake Bay Governor's School for Marine & Environmental Science*

A student's education is a very valuable tool used throughout his or her life. Beginning early on in education, students are being sorted into academic tracks. These tracks range from advanced to vocational, and the quality of a student's education can be altered by which academic track they fall into. Magnet schools are part of the advanced track that target students who are advanced in certain subjects. STEM magnet schools look for students who excel in math and sciences to enroll into their school. Students who are sorted into these academic tracks are young, and have yet to show their full potential, is it accurate to predict their future academic performance from early ages? This study used the GPAs of students at a public high school and a STEM magnet school to look at how a student's academic performance changes throughout schooling. The GPAs were separated based on gender to see if there is an effect of gender on performance in general, as well as indications of future academic success. ANOVAS were run on the data to find the significant differences. This study allowed the comparison of students' performance throughout school, as well as compared if there if a difference in performance due to school attended, gender, and STEM courses. It was found that there

is no significant difference in students' GPAs who attend public school, but those attending a more rigorous magnet school had a significant drop in GPA. The same trend was evident for the STEM GPAs. There appeared to be no significant difference in GPA trends between the two genders. Academic track sorting can be an accurate prediction of future performance for most students and can help them enroll in magnet schools to challenge their ability.

### **Examining the Relationship between Eye Contact, Learning Styles, and Student Performance**

*Cassady Marion, Southwest Virginia Governor's School*

### **Sleep's Effect on Cognitive Capability in Fruit Flies**

*Michaela McCormack, T. C. Williams High School*

This project explores how varying amounts of sleep affect reaction time and memory retention in *Drosophila Melanogaster* subjects. The purpose of this study was to determine how cognitive abilities, more specifically learning and memory, are affected by sleep. It was hypothesized that the learning index percentage for both the Spatial Orientational and Olfactory tests will decrease if sleep becomes irregular. To test the hypothesis, a DAM (*Drosophila* Activity Monitor) machine was constructed to monitor and align fruit flies on certain sleep schedules. Wingless fruit flies were cultured and two cognitive tests were administered, which included the Olfactory test and the Spatial Orientational learning test. The Olfactory test classically conditioned the flies to go into a tube with a certain scent (CS-) and avoid a different scent (CS+). The flies were trained using electric shocks and tested to see how sleep affects the Olfactory cortex. During the spatial orientational learning test, the flies were put into a petri dish and were presented distractor stripes to measure how sleep affected their vestibular senses. Currently, both apparatuses have been prototyped and preliminary data has been collected. The DAM machine is under construction with the Raspberry Pi and the software used to monitor the fruit flies being debugged. The next step in this project is to complete the DAM machine and further prototype both apparatuses.

### **Testing the Efficacy of Virtual Reality Systems for Educational Purposes**

*Noah Keeney, Central Virginia Governor's School for Science & Technology*

With the many innovations being made in the entertainment field involving the use of Virtual Reality (VR), questions of its further purposes are raised. This study aimed to test the usefulness of VR in education. Eight participants were gathered from a local high school and separated into two groups. One group attended a short, classroom-style lecture and were taught about a set of 15 made up words that had English translations. The other group played a short VR game that attempted to teach them about the same words. After each session, each participant took a short vocabulary quiz that assessed how much they had learned. The average score of the classroom group was 15/15 while the average of the VR group was 14.25. After running a Two-Sample T-test and receiving a p-value of .08 (which exceeded the set alpha value of .05), it was determined that there was no significant difference between the two groups. This did not support the research hypothesis that if traditional classroom techniques and virtual reality systems were both used to teach participants about a particular subject, those who participated in the virtual

reality experiment would learn better than the participants in the standard classroom setting. Despite this, VR still appears to have immense potential for further use in education.

## **Psychology B**

### **The Effect of Personality on Stress Levels and Response to Stress**

*Kirsten McDaniel, Chesapeake Bay Governor's School for Marine & Environmental Science*

A personality type is an individual's unique or underlying personality characteristics which are thought to occur together consistently. Stress is a physical reaction to what the body perceives as harmful. Stress can be handled through coping mechanisms. Coping mechanisms help manage difficult or painful emotions. This study measured the effect of the five domains of a personality on stress levels and coping mechanisms. The IPIP-NEO instrument was used to yield scores for the five broad domains of the Five Factor Model: Neuroticism, Extraversion, Conscientiousness, Agreeableness, and Openness to Experience. The purpose is to help people learn about their stress levels and provide probable coping mechanisms that will help deal with stress. It was expected that high levels of Neuroticism would have higher levels of stress due to more negative thinking and more emotional volatility. High Extraversion levels would lead to more social or outgoing coping mechanisms than low Extraversion. High Openness would have a more diverse range of coping mechanisms due to trying more things. The study found that more conscientious and agreeable people tend to use problem-solving as their response to stress, low scorers on agreeableness or conscientiousness tend to choose to ignore their stress, and the more neurotic a person is, the higher levels of stress they will tend to have. The study found that higher neuroticism scores have higher perceived stress levels and higher levels of agreeableness tend to go with lower stress levels. In addition, more conscientious and agreeable people tend to use problem-solving as their response to stress and more extroverted people tend to do physical activity when stressed. Low scorers on agreeableness or conscientiousness tend to ignore their stress.

### **The Effect of Traumatic Brain Injury on Anxiety-like Behavior in a Rat Model**

*Collin Murphy, Mills E. Godwin High School*

The purpose of this experiment was to determine the effect of traumatic brain injury on anxiety-like behaviors in Sprague-Dawley rats. The United States has seen dramatic increases in events of traumatic brain injury in recent years. Medical treatment for TBI most often targets immediate motor and sensory deficits, but neuropsychiatric sequelae, such as anxiety, are often overlooked and perhaps more dangerous. Various studies have shown correlations between TBI and anxiety later in life. Although the specific causation of adverse psychological effects is unclear, recent research cites over-activation of neuroinflammation as the primary connection. Resulting elevated intracranial pressure has been shown to increase the adverse effects of TBI. It was hypothesized that rats inflicted with TBI would exhibit increased anxiety-like behaviors in the open field test, and these effects would be accentuated in subjects with elevated intracranial pressure. Male Sprague-Dawley rats were assigned to be administered either TBI, TBI with elevated intracranial pressure, or sham injury. Videos of open-field tests performed both pre and

post injury were analyzed for corner activity, which was assumed to be representative of increased anxiety. Cumulative time spent in the corner was compared between treatment groups, and t tests were performed to determine statistical significance. No data points were statistically significant, and the research hypothesis was not supported. Results differed from existing census-based literature. Deviation may be explained by differences between human and rodent stress responses and inherent flaws in the use of rodents as a model for human behavior. Lack of power in the data due to death of some rats during experimentation and EthoVision failure to record certain trials largely accounted for lack of significance.

### **A Study of Substance Abuse on *Girardia tigrina* Sensitization**

*Vijay Nagandla, Mills E. Godwin High School*

The purpose of this experiment was to study the effects of substance abuse on *Girardia tigrina* sensitization to drugs. Substance abuse is a prevalent problem in 21st century society, and early exposure to these drugs have been proven to cause future addictions to more potent and dangerous substances. This study compared two prevalent but less potent drugs, caffeine and ethanol, and investigated into its induction of behavioral changes and sensitized responses in *Girardia tigrina*. A hypothesis was formulated stating that if *G. tigrina* was exposed to caffeine or ethanol, both would produce behavioral sensitization, yet it would be more affected by ethanol compared to caffeine. A 5 mM concentration of caffeine was used for both caffeine-caffeine and water-caffeine (control), while a 0.1% concentration was used for both ethanol-ethanol and water-ethanol (control), with 15 organisms per solution, measured in 0, 2, and 24-hour intervals for motility. Spring water was used for dilution and as a part of the control for the zero and two-hour, intervals. The results indicated that caffeine and ethanol produced behavioral sensitization, but caffeine produced a greater effect than ethanol. A t-test revealed that the data was significant in all intervals except for caffeine-caffeine vs the control after 2 hours. The results may have been due to caffeine and ethanol's classifications as psychoactive stimulants, which increase activity and responses to stimuli, and depressants, which decrease activity and responses to stimuli, respectively. This study could help increase public awareness to the detrimental effects of drug abuse and encourage future studies into behavioral changes in adolescents as a result of drug exposure.

### **The Effect of Multitasking on the Efficiency of Task Completion**

*Robert Newman, Mills E. Godwin High School*

The purpose of this experiment was to find the effect of multitasking on the efficiency of task completion. The efficiency of task completion was measured as two dependent variables referred to as the amount of time needed to complete each of the tasks and the quality of completed tasks. As advancements in the workplace demand more work to be completed, rates of multitasking have been increasing among the workplace. Participants completed tasks in the following orders (1. Sorting 2. Copying 3. Sketching), (1. Sorting + Copying 2. Sketching), (1. Copying + Sketching 2. Sorting), (1. Sorting + Sketching 2. Copying), and (1. Sorting + Copying + Sketching). The control group in the experiment was the level of independent variables in which tasks were completed one at a time. It was hypothesized that multiple tasks being completed at once would result in the tasks

being completed faster with a much lower quality of completion. The results revealed that (1. Sorting Buttons + Copying Definitions of Words + Sketching a Picture) had the shortest average window of time and the lowest quality of task completion. A t-test was done on the data for both dependent variables and both proved the data was significant and supports the research hypothesis. This is most likely due to the fact that the brain wires itself to more complex tasks but not as much for more simple tasks. This research could potentially change the workplace and what occurs in it.

### **The Effect of the Pollyanna Principle on the Word Order of Non-antonym Pairs with Opposing Connotations**

*Henry Newton, Central Virginia Governor's School for Science & Technology*

### **The Effect of Neuroticism on the Accuracy of Eyewitness Testimony**

*Vibhas Panchal, Mills E. Godwin High School*

The purpose of this experiment was to determine whether or not the level of neuroticism a person exhibited affected a participant's ability to accurately recall events in an eyewitness testimony situation. A hypothesis was formed that is the participant viewing the videos had low neurotic tendencies, then he or she will have a low percent change in estimated speed between the videos. Since eyewitness testimony is a critical part of many criminal law cases, advances in perfecting the general understanding of its limits would be beneficial. Percent change was determined through the estimated speed by the participant from two videos, where each participant, either high or low neurotic, was asked in different ways. The high neuroticism group had a lower average, with a percent change of about 12.9%, whereas the low neuroticism group had an average percent change of about 13.9%. In addition to the averages being so similar, the statistical data was not significant, meaning the deviation in data was more than likely caused by chance. Further study can be conducted on the impact of any of the other 4 aspects of the Big 5 Theory of Personality to eyewitness memory recall.

### **Investigating the Association of the A1 Allele of the Dopaminergic DRD2 Gene with Extraversion in Teenagers**

*Binal Patel, Southwest Virginia Governor's School*

### **The Effect of Participants' Background on their Perceptions of Character Designs**

*Annabelle Paulette, Central Virginia Governor's School for Science & Technology*

The purpose of this study was to observe how character designs were perceived and any factors in participant background information that could affect those perceptions. The study was conducted through an online survey hosted by google forms. Participants were invited to participate through a link on social media or through email. The survey questioned them on demographic and background information, such as race and television usage. The second part of the survey questioned participants on which character design portrayed a trait best. Three sets of characters were drawn to portray intelligence, aggression, and heroism, respectively. Within each set were a male and female character each for three races. A total of 89 people completed the survey, including 10 people of color and 15 men. Chi-square tests of independence were used to compare participant background information and opinions of character designs at a .05

alpha level. Some background information was significant when compared to character design responses, such as race and gender, but other information was not. Six questions surrounding character designs were compared to background information, and not every question was significant in those comparisons. Therefore, some questions supported the hypothesis that background information affected how character designs were perceived. More specifically, the significant results suggest that racial minorities and those of different genders connect positive traits to characters that represent their race or gender.

### **The Effect of Letter Arrangement in Misspelled Words on Subject's Ability to Detect Error**

*Daniel Philip, Mills E. Godwin High School*

### **The Effect of Mindfulness Meditation on Working Memory**

*Ryan Poquis, Mills E. Godwin High School*

The purpose of this experiment was to find the effect of mindfulness meditation on working memory. Recently, mindfulness meditation has been studied frequently and has been used to treat neurodegenerative diseases. To test the validity of these findings, high-school students performed mindfulness meditation for zero, five, ten, or fifteen minutes for five days, and then were given an "n-back" working memory assessment (NBWMA) upon completion to test their working memory. The control used in the experiment was zero minutes. It was hypothesized that if students performed fifteen minutes of mindfulness meditation, the scores would improve the most on the NBWMA, similar to the findings in other experiments. The results indicated that after meditating for fifteen minutes, students scores' improved 4% more than ten minutes, and 7% more than five minutes. Six t-tests were performed on the data, which revealed that all of the data collected was statistically significant. The results supported the research hypothesis, and there is a linear correlation between mindfulness meditation time and working memory. It is believed that the results are due to the mindfulness meditation activating the areas of the hippocampus, which has a major role in learning and memory. Another possibility that a linear correlation was possible could be the repeated brain stimuli, because the same working memory task was used for all levels of the independent variable. Having different subjects for each level of the independent variable could alter the results.

### **The Effect of Time of Day on Academic Performance**

*Shreya Rajkumar, Mills E. Godwin High School*

The future depends on how well the next generation is educated. One way to ensure the highest standard of education is to control when classes are taught, especially math, where class placement doesn't impact just one year's achievements, but three. The purpose of this study was to see what the effect of time of day was on student academic performance. The research hypothesis was that if students were tested during second, third, and seventh period, then the students tested during seventh period would have the lowest performance. There was no control, as there was no class that had expected results and no class period zero or one that was studied. The experimenter got into contact with a math teacher at a local high school and wrote a five-question quiz for their students to take. The students were all quizzed, then the quizzes were collected and graded. The results rejected both the research and null hypotheses. These results may

have been due to the fact that the students quizzed earlier in the day were quizzed around noon, which is when alertness dips. Further experiments should quiz all the students at the same time so that the only difference is when they learned the material, which should be something that would be hard to learn outside of school. Additionally, the sample size should be much larger.

### **The Effect of Personality on Decision-making**

*Chloe Ramsey, Central Virginia Governor's School for Science & Technology*

The purpose of this project was to investigate personality traits amongst incarcerated and non-incarcerated individuals and determine if incarceration affected an employee's wage after being released. Participants completed five demographic questions (regarding salary range, incarceration status, gender, etc.) followed by 20 survey questions that examined certain personality aspects. The survey questions measured for either surplus amounts of extraversion or higher levels of agreeableness on a scale of 1-5 (five indicating the highest content of that trait). The submitted scores were tallied up according to the specific personality trait measured in those questions. The Two-Sample t-Test investigating extraversion against incarceration status suggested no significance as the p-value (.51) was much higher than the alpha (.05). Similar results occurred when another Two-Sample t-Test suggested no significance between levels of agreeableness and histories of incarceration as a result of the higher p-value of .06 when compared to the alpha of .05. A final Two-Sample t-Test was run to examine the economic effects of incarceration and suggested a significance because of a lower p-value (.02) than the alpha (.05). The research hypothesis that predicted incarcerated individuals would test as extraverts with lower levels of agreeableness was not supported. However, the researcher also predicted that previously incarcerated individuals would receive lower, current salary ranges than those at liberty, which was supported. Therefore, this project concluded that there was no connection between personality and incarceration, but there was a significance regarding salary ranges post incarceration.

### **Examining the Extent of Milgram's Obedience Study**

*Christoph Schoer, Washington-Lee High School*

### **Memory Retention of Details in Adolescents**

*Nadine Shannon, Southwest Virginia Governor's School*

In the current criminal justice system, the methods to interrogate suspects involve heavily investigating alibis and rigorously questioning suspects about details and events pertaining to the certain crime. Unfortunately, there have been hundreds of proven cases of false convictions, and even more undiscovered, as a result of evidence stacked against the innocent suspects. One type of this evidence common in cases has been suspects' failure to correctly remember information, often from a long period of time before. In this particular study, to analyze the retention rates of high school students, and the effect of time, 28 participants were given a passage and questions to answer one day, and split into two groups to return either the next day or two days after to recall the color shirt the researcher had worn the first day. Of the participant group that returned the day after (control group), 57.14% remembered the shirt color correctly, while only 14.29% of the participant group that returned two days after (experimental group) remembered the shirt color correctly. Using the chi-squared test to analyze the data, the results of the two



groups proved to be significantly different, showing that even adding one day to the period of recall makes a large difference in the accuracy of a nonessential memory. These results demonstrate that human memory is not perfect even after a short amount of time, and that memory accuracy deteriorates over time, indicating that the idea that innocent suspects can easily provide a reasonable alibi and correctly recall details is false. In consequence, the tactics and assumptions involved in suspect interrogations need to change to consider the realistic properties of humans' memories, so less innocent suspects are put behind bars.

### **Increasing the Reliability of Eyewitness Testimony Through Strategic Questioning**

*Leila Shepard, Mills E. Godwin High School*

The purpose for conducting this experiment was to determine whether word choice alterations and leading questioning by interrogators could skew eyewitness responses. To test if there was a correlation, subjects were asked to look at two pictures and one video. One picture showed a man, the second picture showed an array of coins, and the video demonstrated a car crash. Questions were created that required a quantitative response from the subjects. The subjects were divided into three groups: Group 1 was asked questions about the visual media that were predicted to elicit a lower numerical response than the actual value, Group 2 was asked questions with neutral wording and no verbal suggestions that were predicted to elicit responses were the closest to the actual value, and Group 3 was asked questions that were predicted to elicit a higher numerical response. As the questions asked to Group 2 were essentially free from bias, this group acted as the control. The quantitative estimations each subject answered to the questions pertaining to the visual media were measured. It was hypothesized if Group 1 was asked questions to the lower extreme, Group 2 was asked neutral questions, and Group 3 was asked questions to the higher extreme, then Group 1 would have responses lower than the actual value, Group 2 would have answers closest to the actual value, and Group 3 would have responses higher than the actual value. It was discovered that only some of the data was statistically significant, and the research hypothesis was only partially supported by the results. Looking closer at the results of the t-tests, it appeared that the part of the experiment testing leading questions had insignificant data while the portions testing word choice had some significant data, indicating that word choice had the greater effect on subject responses.

### **The Association of 5-HTTLPR Gene Variants with Humor Styles of Teenagers**

*Savannah Spencer, Southwest Virginia Governor's School*

Humor has been labeled a valuable trait by society. However, much about how humor works is still a mystery. This study expands the idea that specific humor types are related to a variation of the 5-HTTLPR gene the result in differing serotonin intake. Numerous studies have been completed looking at the 5-HTT serotonin transporter. These studies suggest that a sense of humor is only present in accordance with 5-HTT genes. This study focuses specifically on humor types and how they are connected to the function of 5-HTTLPR serotonin gene and its manipulation of transporter function. This specific study consisted of a survey, DNA extraction, multiple runs of PCR, and multiple gel electrophoresis. Using these methods, results showing 12 of 15 samples having short

alleles and two samples having long allele. Allele type and survey results were run through a Chi Squared Test of Independence produced a p-value of 0.7. This value suggested that humor and the 5-HTTLPR gene are independent from each other. Each of the four humor types were present in survey results. However, statistical assumptions were not met which could have swayed results. Nevertheless, this study provided a needed foundation for future studies in personality traits in association to genetic makeup. In future studies of humor types, a larger sample size would be needed to avoid not meeting assumptions.

### **Generational Joy: A look into sources of happiness and how they change with the times**

*Hannah Swann, Chesapeake Bay Governor's School for Marine & Environmental Science*

The goal of this study was to determine if correlations exist between sources of happiness and the generations of participants, as well as the demographics within them. A survey was given to 161 Generation Z participants and 26 Silent Generation participants, asking them to rank the five qualities out of thirteen that bring them the most contentment in life. The contentment qualities were separated into two categories: tangible (things that are physical in nature) and intangible (things that are not physical in nature). The rankings of each survey were then converted into two scores, one for each category, and combined to give a final score. The more positive the final score, the more the surveyor's sources of happiness were derived from the tangible category's qualities. The more negative the final score, the more the surveyor's sources of happiness were derived from the intangible category's qualities. This study found that the contentment qualities of Generation Z were found more in the tangible category than the Silent Generation. The contentment qualities of both the males and females of Generation Z were found more in the tangible category than the Silent Generation. The contentment qualities of the participants with both urban and rural residency of Generation Z were found more in the tangible category than the Silent Generation. The contentment qualities of the religiously affiliated of Generation Z and the non-religiously affiliated of the Silent Generation were both found more in the tangible category. When all of the demographics were statistically analyzed, however, there was only a significant difference in the average final contentment scores between the generations overall and within the female gender, rural residency, and religiously affiliated. This study sought to find in what qualities of life do human beings seek happiness, and if these qualities differ with age or the time of one's upbringing.

### **The Association of Oxytocin Receptor Gene Variant rs53576 with Optimism and Pessimism**

*Asha Thomas, Southwest Virginia Governor's School*

### **The Effect of Different Class Types on the Successfulness of the Signaling Theory**

*Erum Vohra, Mills E. Godwin High School*

Schools have been identified as environments where signaling and countersignaling take place. However, different class types, like Honors and College Prep, have not been tested for variations in their perceptions. The purpose of this experiment was to determine the differences in the theories that Honors, and College Prep students use to signal their

abilities. The formulated hypothesis was if different class types were tested for their responsiveness to the signaling theory, then Honors classes would have a lower proportion of countersignaling. The experiment was conducted by administering a survey in Honors and College Prep English classes. The surveys were assigned points for analysis based on student answers. There was no control, as all students are unique. The outcome of the experiment indicated that there was no difference in the perceptions of students in different classes, but the proportions of students per classification (Countersignaling, Inconclusive, and Signaling) differed between classes. A chi-square was performed and revealed that the data was significant. Due to the results, the hypothesis was not supported, and the results were most likely due to the concentrations of countersignaling and signaling used by students in the classroom. Further study could include variations of ages.

### **The Effect of Different Electronic Applications on Blinks**

*Aaron Yuan, Mills E. Godwin High School*

The purpose of this experiment was to find the effects of different electronic applications on blinks. Recently, mobile phones have become increasingly important. These phones are leading to new experiences and developments in healthcare, gaming, and social networking. Looking at screens decreases blink rates which leads to future eye problems such as dry eye disease. The blink rates of different electronic applications were measured. Subjects were told to observe no screen and the apps of Temple Run, Instagram, YouTube, and Text Messaging for one minute while blinks were counted. The experiment was repeated twenty-five times to ensure accuracy. It was hypothesized that videogames (Temple Run) would result in the least number of blinks. The results revealed that Temple Run exhibited, on average, two less blinks than Text Messaging and Instagram, one less blink than YouTube, and ten less blinks than no screen. Multiple t-tests were performed, comparing each level of the independent variable to the control (no screen). This revealed that the data for each value was significant. The results supported the research hypothesis. It is believed that the results were due to videogames having the highest workload towards the eyes due to the focusing on many different aspects. This research could lead to further studies by testing which angle and brightness produces the most blinks.

### **Statistical Analysis and Inferences**

#### **The Effect of I-66 Tolling on I-66 traffic**

*Thomas Ackleson, Washington-Lee High School*

#### **The Effect of Ethnicity on Medical Compliance of Kidney and Liver Transplant Patients**

*Gowre Gautham, Deep Run High School*

#### **The Effects of Resolution on Animation Quality**

*Keeshara Harris, Portsmouth STEM @ I.C. Norcom High School*

#### **Traumatic Brain Injury (TBI) Effects in Relation to Sex and Age**

*Emily Neel, Central Virginia Governor's School for Science & Technology*

**Do Government Enforcement Actions Against Undocumented Immigrants Affect Locality Decisions of Legal Immigrants?**

*Zoe Powers, Washington-Lee High School*

**Investigation of the Relationship between Fitness Trackers and Physical Activity**

*Grace Shockley, Southwest Virginia Governor's School*

**Examining Correlations among Regional U.S. & Chinese CO2 Emissions, Populations, and GDPs**

*Jamael Smith, Central Virginia Governor's School for Science & Technology*

**The Effect of Weaning Weight on Dollar Value of Angus Cattle**

*Jenna St. John, Central Virginia Governor's School for Science & Technology*

**Regression Modeling of U.S. Health Care Costs**

*Allyson Wang, Mills E. Godwin High School*

**Identifying and Evaluating Effective Predictors for High School Success**

*Jerry Zhang, Mills E. Godwin High School*

**Zoology**

**The Effect of Different Cleansers on Change in Weight of Used Motor Oil – soaked Bird Feathers**

*Shraddha Anup, Mills E. Godwin High School*

The purpose of this experiment was to find the effects of different cleansers on change in weight of used motor oil-soaked bird feathers. Many aquatic birds are harmed increasingly by the effects of motor oil spills. Bird feathers become matted, thus causing the birds to ingest the oil in efforts of preening their feathers. This causes many issues for the aquatic life that lives in lakes and rivers that are impacted severely by many motor oil spills. Bird feathers were soaked in motor oil and left to dry overnight. The next day, they were cleansed using different cleansers (Dawn, Kirkland, Talc, Water – the control, and Himalaya). It was hypothesized that Dawn Dish Soap would provide the highest change in weight when compared to other cleansers. The results revealed that Dawn Dish Soap did in fact have the highest change in weight, and talcum powder had the least. A t-test was done on the data and it revealed that the data was significant for all of the cleansers used. The results did support the research hypothesis. It is believed that the results are due to the fact that Dawn is designed to erase grease from dishes without harming hands, which is why it is popularly used to clean birds and animals. Dawn is petroleum based, which is something that should be further investigated. This research could lead to further studies that investigate how cleansers not found in largely populated areas could affect different aquatic life.

**Assessing the Pipefish Population in the Chesapeake Bay**

*Katherine Casper, Chesapeake Bay Governor's School for Marine & Environmental Science*

Biodiversity is being threatened throughout the world due to habitat loss, environmental degradation, and the mass killing of animals. In the Chesapeake Bay, benthic habitats like oyster reefs and grass beds have been destroyed leaving only mud bottom for many species to survive on. The destruction of SAV beds has put stress on the pipefish population in the Bay forcing migration of the fish to other less desirable habitats. This study explores the species diversity of *Syngnathidae* in the lower Chesapeake Bay over the summer and across various benthic habitat types. Each *Syngnathus* pipefish length was measured and its defining characteristics were recorded after photographing the organism. Using the photos taken in the field, the fish were identified as one of the three most common species found in the Bay: *Syngnathus fuscus*, *S. floridae*, and *S. louisianae*. Most of the pipefish were caught in the Hole in the Wall site SAV bottom habitat. At this site, during the entire sampling period, 7 *Syngnathus fuscus*, 16 *Syngnathus floridae*, and 19 *Syngnathus louisianae* were caught. Species diversity varied between the benthic habitats represented by each sampling site and with the changing dates of the sampling period. Therefore, certain species can withstand changing bottom types, salinities and temperatures while others cannot. Constant sampling and research for *Syngnathus* and other species with the title of “least concern” should be considered to create a multi-dimensional image of the population of these organisms throughout the Bay, the threats they face, and how to preserve the necessary biodiversity to continue the high productivity levels throughout the Bay.

**The Effect of Magnetic Field on Bees for Purpose of Hive Relocation**

*Abhay Dharanikota, Mills E. Godwin High School*

The purpose of this experiment was to determine which magnetic field intensity bees prefer. Earth is in its sixth major extinction of biological diversity, and as a keynote species, bees will not only be affected but also directly and indirectly impact other species. It was vital that this experiment was done so that scientists can understand what conditions are more suitable in order to help the honeybee population recover. Bees have magnetoreception which allows them to perceive direction, altitude, and location. It was hypothesized that a magnetic field of 0.25 Gauss would result in a higher number of bees being attracted to that plant. The levels of the independent variable were a 0 Gauss, a 0.25 Gauss, a 0.5 Gauss, and a 0.75 Gauss magnetic field. The control in this experiment was a 0 Gauss magnetic field. Four wooden planters, each with a different magnetic field intensity and Aster plant were placed in a row. Then, the number of bees that went to each planter over the span of an hour was counted. Chi-square tests were conducted to determine if the results were significant or not. The 0 Gauss planter and 0.75 Gauss planter were found to be significant ( $p < 0.1$ ) whereas the 0.25 Gauss planter and 0.5 Gauss planter were found to be not significant ( $p > 0.1$ ). This experiment showed that bees prefer higher magnetic field intensities as 44.8% of the bees went to the 0.75 Gauss planter. The effect of magnetic field on bees for purpose of hive relocation was studied to help the bee population recover and benefit the agricultural industry.

**Counting penguins: Expanding animal conservation through neural network and citizen science integration**

Henry Ge, Mills E. Godwin High School

### **Comparing Levels of *Clostridiaceae* Abundance in Equines at High-risk Versus Low Risk for Laminitis**

Isabelle Hollars, Southwest Virginia Governor's School

This project examines the relationship between Laminitis and the bacterial family, *Clostridiaceae* in healthy horses and those that are high-risk for the condition. Laminitis is a condition common in equines where the tissues inside of the hoof become inflamed. Laminitis is linked to diet and nutrition; however, specific causes on the bacterial scale are still largely unknown. Previous research found a large gap in the levels of *Clostridiaceae* in healthy horses and those that were chronic for Laminitis. The alternate hypothesis was that there would be a higher level of *Clostridiaceae* present in low-risk individuals than high-risk individuals and the null was that the levels would be equal for both groups. Fecal matter was externally collected from 3 low-risk horses and 3 high-risk horses. The fecal samples were then disrupted using bashing beads prior to being purified using a DNA extraction kit. After purification, PCR was performed on the DNA samples using primers specific to *Clostridiaceae* and general 16s bacterial primers. Gel electrophoresis were performed, and bands were counted. After running PCR on samples that were undiluted, one band was present for a high-risk sample using a *Clostridiaceae* specific primer and no bands were present for any sample using 16s primers, suggesting the change in *Clostridiaceae* levels could occur after an individual has Laminitis. For the normalized samples, no bands were present for any sample using either of the two primers. These results suggest numerous potential errors in DNA isolation and purification in the study. An exact goodness of fit test was performed on the data showing the observed results were statistically different from the expected. The information learned from this study offers new insight into the relationship between *Clostridiaceae* levels and Laminitis and provides a foundation for further research on the change in *Clostridiaceae* levels in individuals who have Laminitis.

### **The Effect of UV Radiation on *Dugesia tigrina* Regeneration**

Mrunal Kute, Mills E. Godwin High School

The purpose of the experiment was to analyze the effect of ultraviolet radiation on the regeneration process of *Dugesia tigrina*. Due to human-related activities, the ozone layer is depleting at a detrimental rate, facilitating the release of ultraviolet radiation into the earth's atmosphere. The excessive amounts of radiation directly affect organisms' regenerative processes, causing skin damage and increasing the risk of skin cancer, especially for humans. In the experiment, *D. tigrina* were cut in half and distributed into two groups, anterior and posterior, and were exposed to either 2 minutes, 4 minutes, or 6 minutes of ultraviolet radiation; the control of the experiment was 0 minutes of radiation. It was hypothesized that if the anterior portion of the *Dugesia tigrina* is under the UV-C lamp for 6 minutes (Experimental Group 1C), then the percentage of regeneration will be less compared to Experimental Group 1A and 2A (2 minutes), Experimental Group 1B and 2B (4 minutes), Experimental Group 2C (6 minutes), and Control 1 and 2 (0 minutes). This is due to a direct correlation between the production of neoblasts, cells which allow for the *D. tigrina* to regenerate, and the direct exposure of UV-C radiation. The results indicated group 1C regenerated the least as hypothesized previously. Furthermore, a t-

test was conducted on the data, proving the significance, thus, the research hypothesis was supported. The results obtained in the experiment are explained by the fact that the higher the amount of exposure to ultraviolet radiation, the lower the percentage of regeneration.

### **The Effect of Colloids on Survival Rate of *Daphnia magna***

*Abhinav Mara, Mills E. Godwin High School*

The purpose of this experiment was to study the effects of colloids on *Daphnia magna* survival rate. The production of nanomaterials has been constantly increasing, and in result, colloidal metals, which contain metal nanoparticles, end up in the environment and harm the ecosystem. In this experiment, *D. magna* were placed in cultures with colloidal silver, colloidal copper, colloidal gold dilutions and without any colloids. The *D. magna* were placed in the environments for a 220-minute period and were checked every 20 minutes to record their survival. The control during the experiment was normal spring water without colloids. The results displayed that colloidal copper had the lowest survival rate of *D. magna*, and colloidal gold had the highest survival rate. The control did not have the highest survival rate, but the data point is an outlier. The chi-square test deemed that the data was significant for the colloidal gold vs. expected, colloidal copper vs. expected, control vs. expected. However, the chi-square revealed that the data was not significant for colloidal silver vs. expected. The results did not support the research hypothesis. It is believed the results are due to three factors: density, thermal conductivity, and behavior with organic particles. Copper could bind with organic particles and had high thermal conductivity. Silver was quite dense and had a high thermal conductivity, while gold had the highest density. These three factors definitely had major effects on the results of the experiment.

### **The Effect of Gold Nanoparticle Size on *Daphnia magna* Heartbeat**

*Christopher Marotta, Central Virginia Governor's School for Science & Technology*

The purpose of this experiment was to provide more data on the effect that gold nanoparticle size and presence have on an organism. *Daphnia magna* were placed into beakers with 300ml of spring water. One set of beakers contained no nanoparticles for the control group. For the two test groups, 40ml of gold nanoparticles were added to their sets of beakers, one group used the 5nm size particles and the second used the 10nm size. After sitting in the beakers for seven days the *Daphnia* were then placed under a Zeiss Primo Star microscope and their heart rate was recorded. The video recordings of the *Daphnia* heartbeat were then transcribed into a table to allow for statistical analysis. The mean values for the control, 5nm, and 10nm groups were 327.4bpm, 327.9bpm, and 329.3bpm respectively. An ANOVA test was performed to determine the significance of gold nanoparticles on *Daphnia magna* heartbeat. This test resulted in a p-value of .99 which was considerably higher than the set alpha value of .05. This data did not support the research hypothesis stating if *Daphnia magna* are exposed to different sizes of gold nanoparticles, then the heart rate of the *Daphnia magna* will rise as the size of the nanoparticle increases. This experiment supports the conclusion made by other similar experiments stating that gold nanoparticles do not seem to have any major side effects on an organism.

## **The Effect of Different Nutrients on the Attraction of *Tapinoma sessile* (odorous house-ant)**

*Keagan Miller, Clover Hill High School*

## **The Effect of Different Macronutrient-concentrated Diets on Cricket Weight**

*Thomas Moore, Mills E. Godwin High School*

It is estimated that around 2.5 billion people consume insects each year to substitute for important foods including sources of protein. Crickets, when compared to pork, beef, and chicken, not only contain just as much protein in a 100-gram sample but contain essential minerals that other sources of protein lack. The purpose of the experiment was to discover if different macronutrient-concentrated diets had an effect on the weight of crickets. A research hypothesis was formed stating that if crickets were exposed to the protein, then they would experience the most growth. Three levels of the independent variable had 25 crickets each, and measurements of net weight were taken weekly for a total of three weeks. The precision of the data was observed by the variance and standard deviation, with the protein having the most precise data, followed by the carbohydrates and lastly the control group. Multiple t-tests were used to perform statistical analysis on the data. The findings of the t-test showed that all of the data was statistically significant, as a result of the calculated t-test being lower than the table t-test. The comparison of using the concentration of protein and carbohydrates in cricket diet could provide an explanation as to why the results were obtained. Because the protein-exposed crickets did not have nearly the amount of carbohydrates maximized for weight gain, it was possible that the lack of necessary energy for growth related activities in the body of the crickets stunted growth, causing the leveled outgrowth.

## **The Effect of Tyramine on *Daphnia magna* Heart Rate**

*Michael Murphy, Mills E. Godwin High School*

The purpose of this experiment was to test if tyramine had an effect on *Daphnia magna* heart rate and what this could mean about human blood pressure. Blood pressure is a major issue in America and kills thousands of people every year. Tyramine is a chemical found in many foods and is known to cause high blood pressure but in what doses is it worst for people. It was hypothesized that the more tyramine that was in the solution the higher the daphnia heart rate would be. This was tested by having 75 daphnia heart rates measured while in solutions containing different amounts of tyramine. The first 25 daphnia were placed in a container with just filtered spring water which was the control because this is the environment daphnia are normally in. The next 25 daphnia were placed in a solution contains 0.3g of tyramine powder. After the daphnia had time to absorb the solution, the heart rates of those daphnia were recorded. For the final 25, the daphnia were placed in a solution containing 0.6g of tyramine and the heart rate was recorded. The results showed that the tyramine had little to no effect on the daphnia. This was concluded because a t-test was done, and it showed that none of the results were significant. The results didn't support the hypothesis. This could have happened because of errors in experiment.

## **The Effect of Various Concentrations of Capsaicin on *Pogonomyrmex barbatus* Avoidance**



*Patricia Anne Mutia, Mills E. Godwin High School*

Demonstrating the avoidance of the ants, the applications of the experiment allow for the improvement of repellents utilized in agriculture or towards pests economically and ecologically. The purpose of the experiment on the effect of various concentrations of capsaicin on *Pogonomyrmex barbatus* avoidance was to explore how the ants avoid even low concentrations of capsaicin with its deterrent capability, specifically due to its pungency. The research formulated hypothesis was if *P. barbatus* are exposed to various concentrations of capsaicin, then they will avoid the solutions with higher concentrations of capsaicin. Capsaicin was extracted from árbol chili peppers placed in acetone, filtered, and evaporated. The concentrations were created by diluting the capsaicin with whole milk. The avoidance of the ants was measured through counting the number of ants in areas without the mixture in pictures taken every minute within a 20-minute duration. The ants were placed in a plastic container when not being exposed to the concentrations. The levels of capsaicin to milk ratios were 1:0 as the negative control, 1:2, 1:4, 1:6, and 0:1 as the positive control. With 12 of the calculated t values not statistically significant while eight were, the results were most likely due to chance and error than the independent variable, so the null hypothesis was not rejected. The observed negative control had ants avoid it, which was not expected and may have caused an error in the t-test. Errors may have occurred because of the sample size and during the capsaicin extraction.

### **The Effect of pH on Type and Number of Daphnia Eggs**

*Shrinidhi Nadgouda, Mills E. Godwin High School*

Ocean and freshwater acidification is a major consequence of increasing atmospheric CO<sub>2</sub> absorption by oceans and bodies of freshwater, which negatively affects marine nutrient cycles, biodiversity, and organismal productivity and survival. The purpose of this study was to investigate whether pH would affect *Daphnia magna* stress response through observing type and number of eggs produced after being exposed to various pHs (8.1, 8.0, 7.9, 7.8, 7.7) for 48 hours. A pH of 8.1 served as the control to mimic the current state of the oceans and most freshwater lakes. It was hypothesized that if the pH of water *Daphnia magna* were in was an environment of pH 7.8 or lower, then decreased egg production would be seen and if eggs were produced then only protected eggs would be observed. Type and number of eggs were observed under a microscope. *D. magna* in a pH of 8.1 had the highest average number of eggs, and in a pH of 7.9 had the lowest. All eggs produced were protected and no unprotected eggs were produced, but a large number of the *D. magna* did not produce eggs at all, possibly due to potential sources of error. Five chi-squares were done for the type of egg, and all were significant. Four t-tests were done for the number of eggs and none were significant. It was concluded that pH affects type of egg, but not number of eggs produced. Similar studies show that *Daphnia* are highly sensitive to pH, and these results were significant as expected. For valid further research, increased intervals of time for species to acclimate to their surroundings are required.

### **The Effect of Electrolytes on *Daphnia magna* Heart Rate**

*Ruthrathathy Patanjali Babu, Mills E. Godwin High School*

This experiment was constructed to test the effect of electrolytes on the heart rate of *Daphnia magna*. In this experiment, *Daphnia magna* was tested on with three solutions that had different concentrations of electrolytes: one being the control, spring water, the other two being coconut water and an unflavored electrolyte solution. The whole process took one day that consisted of counting the heart rate of daphnia and viewing of the Daphnia through a stereoscopic microscope. When viewing, the Daphnia was placed on a microscope slide, then one ml of spring water was placed on the Daphnia. The heart rate was counted. This process was repeated 25 times with each of the three solutions. With these data points, a t-test was calculated, which stated that the experiment was significant. This supports the research hypothesis. This was probably since *Daphnia magna* is sensitive to ph. that are above or below 6 or 7. Thus, it was concluded that electrolytes increase daphnia heart rate.

### **Juvenile Blue Crab Densities in Seagrass Beds and Shallow- water Creeks within the Lower Chesapeake Bay**

*Christina Pelliccio, West Potomac High School*

Due to recent fluctuations in juvenile blue crab densities and because blue crabs play such a vital role in marine ecosystems, their population must be monitored to ensure their stability and also improve the management of coastal fisheries. In order to do this, a field study was designed in order to extrapolate data for the size and densities of juvenile blue crabs in vegetated and non-vegetated habitats within the lower Chesapeake Bay. Scrapes were used to take samples of the non-vegetated habitats (shallow-water creeks) and suction samplers were used to take samples of the seagrass beds. Samples were frozen and then sorted through for juvenile crabs in the lab. When looking at the overall differences in crab density between suction samplers and scrapes, the density of the crabs in the suction samplers was about five times that of the crab density in the scrape samples. Overall, the hypothesized positive correlation between seagrass percent cover and crab density proved to be true. For crab ages, almost all of the crabs sampled in both vegetated and non-vegetated locations were age-0, but the shallow-water creeks had a slightly higher number of age-1+ crabs than the seagrass beds did. Also, the crabs were generally much larger in the non-vegetated sites than in the vegetated ones.

### **The Effect of Light Bulbs on Insect Behavior**

*Annabel Puritz, Mills E. Godwin High School*

The purpose of the experiment was to find the effect of different types of light bulbs on *Galleria mellonella* behavior. The use of artificial lights outdoors has a large impact on insects with positive phototactic behavior, causing the insects' population to decline. In the experiment, several types of light bulbs were tested to determine which light bulb would be the safest to install outdoors. It was hypothesized that LED lights would attract the least number of insects and therefore would be the least impactful on the environment. Four light bulbs were tested: incandescent, compact fluorescent, halogen, and LED lights. The data was collected by observing how many moths were attracted to each light in the timespan of five minutes. There was no control in the experiment because it is commonly known that moths are not attracted to darkness. The data indicated that LED light bulbs had attracted the least number of moths and the incandescent light attracted the most moths. The moths were more attracted to light bulbs with higher ultraviolet light emissions.

These results had supported the research hypothesis, however, most of the data was not significant. It is believed that the results were caused by error and chance rather than the levels of the independent variable. Each light bulb rarely attracted any moths because the moths did not move. The moths may have been affected by their environment. The experiment was performed indoors rather than in a natural habitat. Further studies on moths should be performed outside in the correct environment.

### **The Effect of Humidity on the Madagascar Hissing Cockroach Reproduction Cycle**

*Morgan Ralph, Southwest Virginia Governor's School*

### **The Effect of Repetition of a Maze by *Cassius auratus* on Completion Time**

*Ben Tharakan, Mills E. Godwin High School*

The purpose of this experiment was to investigate the effects of increased repetitions of a maze by *Cassius auratus* on its completion time of the maze. Zero Repetitions (control), Five Repetitions, Ten Repetitions, and Fifteen Repetitions were the three different repetition numbers chosen to represent the three levels of the independent variable. When an activity is repeated in the same manner and using the same neuron pathway, the myelin sheath is increased, reducing the amount of energy lost, and thus reducing the reaction time. Zero Repetitions was used as the control since it was the baseline completion time of the maze. A research hypothesis was formulated that if the number of repetitions of the maze was 15, then the fish would have the lowest average completion times. Every 12 hours for the next ten days, the fish maze was inserted into the fish tank and 25 Aqueon Goldfish Granules were dropped into the tank. Right when the food was dropped in the water, the stopwatch was started and once one fish reached the other side, the time was recorded in seconds in the data table. After performing analyzing and performing t-tests on the data, it was discovered that Fifteen Repetitions did produce the lowest completion times, so the research hypothesis was supported.

### **Observing the Effects of Organic Insecticidal Soap on Hatching of *Callosobruchus maculatus***

*Mia Varghese, Glen Allen High School*

This experiment was conducted to investigate the effects of different concentrations of organic insecticidal soap on the hatch rate of *Callosobruchus maculatus*, also known as the cowpea weevil. These beetles both lay eggs and feed on various types of beans, hence giving them the nickname "bean beetles." In this experiment, black-eyed peas were used as the mating and hatching grounds for beetles. The main objective was to test which concentrations of organic insecticidal soap would be most effective as protectants of the black-eyed peas, and it was hypothesized that lower concentrations would be as effective as higher concentrations. If the lower concentrations worked just as well as the higher concentrations, farmers wouldn't have to spray the full concentration of insecticide, which saves money and prevents environmental and health issues in plants and consumers. Four concentrations of the soap were used: no concentration, 1% concentration, 10% concentration, and 100% concentration. The no concentration group was used as the control, and nothing was sprayed on the beans. Each concentration had four trials and each trial consisted of 20 eggs. At the end of the experiment, the alive and

dead beetles that hatched were counted. Results indicated that there wasn't a significant difference between the 1% and 10% concentration groups (in terms of the total number of beetles that hatched) but there was a significantly lower number of beetles produced in the 100% concentration. Although varied in individual trials, the findings disagree with the hypothesis that lower concentrations of insecticide are equally as protective as higher concentrations. Limitations included temperature and humidity differences and failure to look at age of eggs before study, which is why further research in the field is needed to elaborate on these findings.

### **The Effects of Salinity on Oyster Growth**

*Rosalina Volo, Chesapeake Bay Governor's School for Marine & Environmental Science*

Over the past 100 years the oyster population in Chesapeake Bay has decreased significantly, and this is why this study is so important. Many people and organizations are trying to plant more oysters at different places to help build up the population, so this study will show what salinity helps grow oysters the best. This experiment was conducted over a series of five months over four different sites in the Rappahannock River. The growth of eastern oysters was measured under the conditions of different salinities. Lower salinities decrease oyster filtration rates because they increase energy expenditures on osmotic management. The results that were predicted for this experiment is that as the salinity increases that growth also increases and make for better oyster growth. My results were highly significant with very low p-values, from a custom General Linear Model with on categorical variable (site/salinity) and one continuous variable (time in days). Because this study found that increasing salinities increased oyster growth by weight and by length and width, this shows that it is best to grow oysters in higher salinities than in lower ones.

### **House Flies as Disease Vectors**

*Caroline Wigboldy, Central Virginia Governor's School for Science & Technology*

The purpose of this experiment was to determine if *Musca domestica* contaminate surface area at a faster rate earlier on, or contaminate at a constant rate, during a specific time period. The research hypothesis was if *Musca domestica* contaminated surface area for 3 hours vs. 24 hours, then *Musca domestica* would contaminate surface area at a faster rate during the 3-hour time period. Each house fly was placed into its own Mason jar with a LED glow powder-sugar mixture and remained there until the designated time interval was over. Photos were then taken of each Mason jar under black light, illuminating the areas that the flies contaminated through the LED glow powder. This process occurred twenty times, ten for each time interval (3-hour, and 24-hour). Images were then analyzed in a photo analysis software, ImageJ, and converted into contamination rates (mm<sup>2</sup>/hour). A two-sample t-Test (assuming equal variances) determined there was no statistically significant difference between the groups, because the p-value of .09 was greater than the alpha value of .05. In addition, although the data showed that the average contamination rate of the 3-hour trial, 29.77 mm<sup>2</sup>/hour, was greater than the average contamination rate of the 24-hour trial, 15.25 mm<sup>2</sup>/hour, the hypothesis was not supported since there was no statistically significant difference. Overall, this experiment did not show statistically significant results as far as differences in the rate of

contamination. However, these results can help elucidate how flies explore their environment and transmit disease.

### **The Effect of Curcumin on the Regeneration Rates of *Girardia tigrina***

*Paul Yang, Mills E. Godwin High School*

The purpose of this experiment was to use *Girardia tigrina* as a model system to study regeneration in the human body. In today's society, chronic and severe acute injuries are a major concern in the medical field. This study was an investigation on curcumin's conceivable medical properties and its potential for use. It was hypothesized that if different amounts of curcumin are given to bisected planaria, 15mg will produce the optimum results. Forty milliliters of bottled spring water were poured into twenty petri dishes and curcumin powder was poured in afterwards. One hundred planaria were bisected and their heads were placed in groups of five per dish. Upon comparison of the means of 0mg (control) (6.28), 5mg (6.68), 10mg (7.92), and 15mg (0), varying dosages of curcumin very clearly affected the length or otherwise rate of regeneration. Two of three calculated t-values were greater than the table value of 2.682, so data was still mostly due to the independent variable. The findings showed that an increased dosage of curcumin provided beneficial effects to regeneration to a certain extent. Planaria receiving 15mL most likely experienced adverse effects due to an over dosage similar to a study that was conducted on rats. Because free radicals cause wide range tissue damage, curcumin's property as an antioxidant is most likely the reasoning behind its success in increasing the regeneration rates of planaria that received 5mg and 10mg. Overall data was statistically significant and not due to chance.