

# ABSTRACTS

*Seventeenth & Eighteenth Annual Michigan  
High School Early Research Symposia*

Hosted by Andrews University & Berrien RESA

*April 28, 2017 and April 27, 2018*

## 2017 PSA Presentations

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# 2017 Research Presentations

## *Development and Validation of an LC-MS-MS Method to Analyze High Concentrations of Heroin in Oral Fluid*

**Pavitra Attanayake and Teanne Davis**

Kalamazoo Area Math and Science Center

Heroin is a widely abused drug in the United States. Heroin overdose causes suppression of breathing, coma, permanent brain damage and death. Heroin consumption can be measured by the presence of its metabolites: 6-monoacetylmorphine (6MAM) and morphine, which further metabolizes into hydromorphone, normorphine, and morphine glucuronides. These metabolites can be detected in body fluids such as oral fluid, blood and urine. Quantification of drug levels above 500 ng/mL is difficult with existing methods without dilution of the sample. Therefore, a liquid chromatography-tandem mass spectrometry (LC-MS-MS) method was developed to measure heroin and metabolites at higher concentrations in oral fluid.

Four hundred and thirteen samples from Michigan, Ohio, and Indiana, collected from February 2016 to January 2017, were analyzed using the developed method. Oral fluid samples were collected using the Quantisal collection device, and were purified using solid-phase extraction (SPE) prior to analysis. The linear range found was 500-20,000 ng/mL for heroin and 1,000-40,000 ng/mL for 6MAM, morphine, hydromorphone and normorphine. The Lower Limit of Quantification (LLOQ) was 500 ng/mL for heroin, and 1,000 ng/mL for other metabolites. The number of positive samples found for heroin, 6MAM, and morphine were 244, 377, and 225 respectively; no normorphine or hydromorphone positives were found above the LLOQ. The highest numbers of positives found in each state were 14 in Ingham County, MI, 22 in Floyd County, IN, and 15 in Butler County, OH.

## *Implementing the ORCA System for the Prevention of Rip Current Fatalities*

**Nick Basore, Jesse Munson, Max Pleyte & Eli Richardson**

Williamston High School

This project was designed to help curtail the death count associated with rip currents in Michigan, largely due to the Great Lakes. In the past year alone, 20 people have died in the Great Lakes. The ORCA system was designed to help alert swimmers as to when and where rip currents are forming in order to potentially avoid a fatal accident. This project was all about adapting and refining the ORCA technology left to us by the InvenTeam. We had two clear objectives: make the buoy float and keep the buoy from excessively rotating. After testing a multitude of solutions, we settled on making the top of the buoy lighter, which we accomplished by changing the frame atop the buoy. In order to address the second issue, we settled on a multiple anchor system that helped keep the buoy stable and oriented while in the water. We learned that both of these worked very well to solve their respective problems. The engineering restraints based on the spar buoy were the largest issues to deal with in this whole project. Moving forward, if another group were to pick this project up, we would recommend that they use our archetype but change some aspects, such as the buoy's shape. Wrapping around to our initial problem, our improvements to the ORCA system help make it much more viable for use than ever before. In conclusion, while the ORCA may still need some work in order to function in its intended way, our progress this year helped make a much better and more feasible ORCA device.

## *Charting New Territory: Formulating the Dalivian Coordinate System*

**Olivia Burton and Emma Davis**

Williamston High School

The Dalivian coordinate system presents a new way to graph points in a coordinate plane. The traditional way to graph points, in the Cartesian plane, uses an x-axis and a y-axis to plot points horizontally and vertically in a grid. The Dalivian system differs from the traditional system in that points are graphed using the non-origin intersection of two parabolas,

$x = ay^2$  and  $y = bx^2$ . Points are labeled  $(a | b)$ , with  $a$  representing parabolas opening left and right and  $b$  representing parabolas opening up and down. The research mainly focused on identifying generalizations that can be made in the Dalivian system, which later transitioned to proving a few of these generalizations. An integral part of the research was developing conversion formulas. These allow for a conversion between points in the Dalivian and Cartesian systems. They are  $x = \sqrt[3]{(1/ab^2)}$ ,  $y = \sqrt[3]{(1/a^2b)}$ ,  $a = x/y^2$  and  $b = y/x^2$ . Another major part of the research was creating graph paper so one could graph points, labeled as  $(a | b)$ , without having to convert to  $x$  and  $y$  coordinates. The graph paper in the Dalivian system involves four sets of ten parabolas, traditionally starting at  $y = x^2$ , and becoming increasingly narrower. There are a total of forty parabolas featured on the graph, with ten opening in each of the four directions.

### *Analysis of Peer Influence on Child Decision Making: Comparing Behavior and Delayed Gratification*

**Erin Canfield and Isabelle Herb**

Williamston High School

Peer pressure and its manifestation in children is a topic containing research that is vital to parents, teachers, administrators, and law enforcement. Further understanding the effects children have on each other can lead to better ways to handle situations in which these kinds of interactions are involved. This was tested by looking at how children exhibit different skills surrounding delayed gratification; more specifically, how do students' decisions to delay gratification change when the influence of peers is present?

Originally it was believed that individuals would be more likely to delay gratification; that is, when put in a room with a peer, children would be negatively influenced to make a decision which benefited them less in the long run. This was tested among age groups from three years to fourteen years in order to see how this effect fluctuates as children age. Pairs were found to wait more often (87%) than individuals (62.5%) as well as individual girls (66.7%) being more likely to wait than individual boys (58.3%). In general, any time a girl was involved in a trial, the trial member(s) waited more often: girls paired with other girls waited 100% of the time, followed by the boy/girl pairs with 85.7% waiting and lastly boys paired with other boys waited 77.8% of the time.

This would suggest that girls tend to delay gratification more so than boys and that the prediction was false; peers generally influence each other to make decision which are more beneficial in the long run, rather than the reverse.

### *An Inside Look at Atherosclerosis and Coronary Heart Disease*

**Adam Coe and Jacob Goodrich**

Otsego High School

In healthy coronary arteries, blood flows freely to bring oxygen to the heart. In coronary heart disease, these arteries become stiff and narrow, lowering blood flow and the amount of oxygen that gets to the heart. This stiffness is caused by atherosclerosis, a buildup of fatty plaques in the arteries. In the US, 1 in every 4 deaths is caused by heart disease, and well over half of these deaths are attributed to coronary heart disease in particular. Additionally, more than 3 million Americans are diagnosed with coronary heart disease each year. The objective of our research is to determine the exact mechanism by which plaque builds up and narrows the arteries, as well as to hopefully be able to apply this knowledge to reduce the risk of heart disease. We know that coronary heart disease is largely a result of a response that is triggered when low-density lipids (LDL) seep into the inner walls of the arteries and binds with endothelial cells found there. The exact mechanism by which the oxidized LDL stimulates the endothelial cells is currently unknown, which is the main focus of our research. We believe that this response is triggered when the oxidized LDL binds to a certain protein. In the lab, we use several different techniques to analyze how and where this binding takes place.

## *Comparison of Seawater Desalination Methods For Individuals*

**Nick Dailey and Megan Phelps**

Williamston High School

Due to a lack of drinkable water many solutions have arisen to take the salt water from the ocean and desalinate it, or remove salt and other contaminants to make it drinkable. Four of those solutions are; evaporation, filtration, reverse osmosis, and electrodialysis. Each of the four were tested with only two (evaporation and filtration) yielding conclusive results. Three tests were done with each method all consisting of two liters of water. The first test was done with two liters of pure seawater, the second with half seawater and half tap water, and the last with one quarter seawater and three quarters tap water. This was done in order to compare whether the tests were more efficient when running with brackish water, a mixture of seawater and clean water. The evaporation test showed promising results, although it took a while to cycle all of the water through the testing the conductivity which was tested before and after each trial was greatly reduced. This is a positive change as pure water has no charge and the higher the charge the larger number of particles present in the water. The filtration test, though it took much less time, was less promising as a fewer percentage of particles were removed from the water. The reverse osmosis and electrodialysis methods did not yield results as the setup of each was unable to function properly. This leads to the conclusion that the best method for individual use is evaporation.

## *The Electrical Components of Chaos and Their Effect on Circuit Behavior*

**Jamie Hare**

Otsego High School

The behavior of a chaotic circuit is dictated by the values of the electrical components it is made of. This study is to show how the components affect the output of the system and how the same output can be obtained from multiple configurations. There are two parts of a chaotic circuit - the linear and the nonlinear part. The main focus of this research was on the nonlinear part as it can be made multiple ways, the linear part stays the same. Physical breadboards hooked up to an oscilloscope as well as the circuit simulation software LTSpice were used to collect data on chaotic circuit output. Multiple arrangements were used with a combination of operational amplifiers, diodes, and resistors to see if there was a difference between the results. Voltages from different points were compared against each other on an oscilloscope with the goal to get a certain graph based on previous research found. The results obtained were that the different nonlinear systems did not have an effect on the output, but changing the resistor, capacitor, inductor and input voltage had a significant effect. We can conclude from this information that there is not only one way to obtain chaos, but the electrical components can change the size and shape of the graphical results.

## *Examining Grade Point Variations for Potential Inflation in Michigan High Schools*

**Ben Heilman**

Williamston High School

It is the undeniable truth that the average grade given out in high schools has increased dramatically over the last couple decades. However, the concern is that grade inflation is still happening in most of our education systems today. This study compared the fluctuations in GPA and standardized test scores in Michigan high schools over a four to five year period in hopes of identifying possible cases of inflation or deflation. To do this, information was received from participating high schools that anonymously listed every student's GPA and ACT/SAT scores from up to five of their previous graduating classes. Then the data accumulated for each year and school was averaged and compared side by side on proportional charts. An inflation index was also included to numerically show how severely inflated or deflated schools were by comparing the GPA and ACT scores. Of the four schools studied the most common pattern observed among them was deflation. In fact, half of the schools participating demonstrated deflation during every year they were observed. A third school showed initial deflation, however, they reverted back to their original inflation index score by the end of the period.

The final school was the closest school to indicate possible inflation over the research time. They had a steadily increasing inflation index until the third year, where they suddenly deflated, but then quickly inflated again during the final year. According to this information, grade inflation is not a concern for most Michigan high schools. Instead, the data is showing a much more frequent occurrence of grade deflation over the past four to five years.

### *Mitigating the Environmental Impacts of Wastewater Through Atomization*

**Sam Hetherington, Brent Hurlburt & Luke Janecke**

Williamston High School

The main purpose for this research is to explore an alternative way to safely dispose of wastewater and to prove that atomization increases evaporation. The research showed that the atomizer significantly increased the rate of evaporation. The average rate of evaporation due to atomization between the two hubs was .731255 grams per second, which was over 8x the rate of evaporation without the help of atomization, clearly showing that the atomizer had a big impact. Research was also conducted to see if atomization had the capabilities to clean wastewater efficiently and effectively. The environmental hazards that were present with wastewater resulted in the use of saltwater as a substitute. A pipe was used to direct the outflow air to a dehumidifier which would condense the air for testing. The results were inconclusive due to the dehumidifier's capabilities of taking in air from the uncontrolled environment. The data collected did however show that atomization was able to make water drinkable, at a safe conductivity around 1,200 microsiemens/cm, and should be further researched.

### *Comparing Characteristics of Waste Plastic Pyrolysis Fuel to Conventional Diesel Fuel*

**Zach Jewison and Owen Rokita**

Williamston High School

Waste plastic pollution and energy shortages are both pressing issues in today's world. Pyrolysis of waste plastics attempts to solve these problems by eliminating waste from the environment as well as creating a viable alternative fuel to replace conventional fossil fuels, such as diesel. This research examined whether waste plastic pyrolysis fuels are similar in characteristics to conventional diesel fuel and, thus, plausible for use as an alternative fuel. Three distinct waste plastic pyrolysis fuels were created and tested for similarities: HDPE, PP/LDPE, and Mixed. Pyrolysis took place in a ten gallon steel reactor (steel oil drum), which was heated from the bottom by one central burner and four additional Bunsen burners. Vapors traveled through approximately six feet of copper tubing, and bubbled directly into water. Any material that condensed on top of the water in the bubbling container was collected and used for testing. Four tests were outlined to isolate specific characteristics of each fuel. The tests were called efficiency, calorific value, burn time, and relative density and tested for how much the fuel burnt, how energetic it was, how long it burnt, and its density, respectively. The research found that waste plastic pyrolysis fuels were not similar in characteristics and performance to conventional diesel fuel. Results from the tests outlined found that 2.01 grams of diesel had a longer burn time (104.38 seconds) than any of the waste plastic pyrolysis fuels. Diesel also had a higher calorific value (1.413 kcal/g) than any of the other fuels. This finding may vary from the actual calorific value of conventional diesel due to limited access to technology such as a bomb calorimeter. Finally, diesel was also found to have a higher efficiency, as it had the greatest percent decrease in mass (86.05%) when burnt in comparison to the waste plastic pyrolysis fuels. Since there was less mass remaining when the flame died, it means that more of it burnt off in the process, making it more efficient. These results show that conventional diesel was a superior fuel in comparison to waste plastic pyrolysis fuels.

## *Performance of Parallel Solutions for the N-Body Problem*

**Siddhant Pagariya**

Kalamazoo Area Math and Science Center

The n-body Problem has been known for years to be an increasingly complex task when it comes to the computation and prediction of the movement of great than a billion bodies in space. Its computation can be implemented in different algorithms in combination with Parallel Computation techniques to optimize the run time of the program. The purpose of this project is to create and implement the Brute Force and Barnes Hut algorithms in a, both sequential and parallel fashion and analyze the efficiency and computational times of the Barnes Hut algorithm to the Brute-Force algorithm. The researcher implemented the traditional Brute-Force algorithm for the n-body computation and then optimized it to run in a parallel manner, thus optimizing the algorithm's run time. In addition, the researcher implemented a much more efficient algorithm—the Barnes- Hut algorithm in serial and parallel formats to study the change in the computational speed and in turn, the efficiency of such an algorithm when implemented in C++, and with the MPI library. After executing the four implementations with controlled data sets for a varied number of bodies and nodes to run the programs, the researcher found that the Brute-Force sequential program ran with approximately the same time as the predicted run-time of the program and the Barnes-Hut sequential program with different critical opening angles of  $\theta = 0, 0.5, \text{ or } 1$ , showed different behaviors. The parallel implementations of both these algorithms showed an overall decrease in efficiency with the addition of nodes for the program to be run on and showed the expected increase in computational time with increased number of bodies.

# 2017 Poster Presentations

## *Synthesis and Hemagglutination Properties of Boronic Acid Triamines*

**Shania Ahmed**

Berrien County Math & Science Center

In this experiment, the goal is to observe whether or not different boronic acids caused hemagglutination, and to help explain the synthesis of tris boronic acid triamines. I am also trying to explain the process of agglutination, and how it relates to the project that I am trying to carry out. I used different boronic acids and then tested on cleaned human red blood cells. We made the prediction that these specific boronic acids would bind or stick to the cells, creating agglutination. Different blood cells were cleaned and combined with the products for observation of agglutination. However, only two of my products proved to work and these were observed to have caused agglutination.

## *Detecting Dust and Dander Allergens in IgE Sensitized Individuals Using a Capillary Tube Precipitation Test: A New Non-Intrusive Antigen/Antibody Reaction Test*

**Audrey Bakerson**

Berrien County Math & Science Center

The purpose of this research was to determine if a new non-intrusive allergy test can detect dust and dander allergens in IgE sensitized individuals using a capillary tube precipitation test without the associated risks in currently available tests. Eleven samples of saliva were gathered from individuals with known allergies to cats, dogs, both or neither; along with fur from two cats and five dogs. The dander from the fur from each animal was extracted using water and in another trail using acetone. Cat saliva was also used in one of the trails. One milliliter of saliva was put into each test tube along with one milliliter of antigen solution. There were six different trails with a total of 138 tests. Results indicated that this non-intrusive test detected reactions in several of the samples. Further research is needed using a commercially available antigen Can f 1 solving both the concentration and PH issues allowing for more consistent and reliable results. There is no way to truly avoid dog and cat antigens one hundred percent of the time, so hypersensitive people need to be able to quickly, efficiently, and reliably diagnosis exactly what they are sensitive to. This test would make this a reality for millions of people.

## *Synthesis and Properties of Arylidene Thiobarbiturates as Histamine Sensors*

**Bailey Bakerson**

Berrien County Math & Science Center

The purpose of this research is to create a fluorescent sensor that can be used to detect histamine and or histamine equivalent molecules. Through experimentation, the research moved to creating and testing arylidene thiobarbiturates as histamine sensors or histamine equivalents. It was determined that the difference between a primary, secondary, and tertiary amine can be observed through the use of multiple variations of the developed sensor and that histamine can be detected. With this sensor and its ability to work in dry and wet environments, it will be applied to creating a new non-invasive allergy test that could be used at home or in a medical facility.

## *Synthesis and Anticancer Activity of Methoxy $\alpha$ -Cyanostilbenes*

**Daniel Chi**

Berrien County Math & Science Center

In this experiment, the goal is to test the effects of variations of  $\alpha$ -cyanostilbenes against cancer cells. In order to form the  $\alpha$ -cyanostilbenes, combinations of 0.025 mmol of various aryl acetonitriles and benzaldehydes will be formed through the reflux method. After the formation of the product, it was tested against cancer cells using 96 well plates. By using a combination of the product, media, dimethyl sulfoxide, and cell titer blue, the amount of cancer cells inside the 96 well plates can be interpreted from their fluorescence. The cell titer blue, or fluorophore, allows viable cells to convert a redox dye into a fluorescent compound called resorufin. Therefore, if the cells with the product reveal less fluorescence than the control, then the product has reduced the number of cancer cells. In this experiment, our hypothesis is that if the  $\alpha$ -cyanostilbene is synthesized and used on cancer cells, then it will reduce the cell growth of cancer cells.

In the results and fluorescence data received from the 96 well plates, the data showed that some compounds, especially the formylphenylboronic acids, reveal anticancer properties at certain concentrations. We also found that the different concentrations can also yield cell growth properties depending on the compound used. This shows that our hypothesis is partially correct, as the  $\alpha$ -cyanostilbene has shown to reduce the growth of the cancer cells but can also induce growth depending on the concentration. Additional future work can be done by taking the NMR of the compounds in order to confirm the compounds used in the cancer cells and also more testing on different compounds.

## *Rare Amino Acids Accelerate Cancer Growth*

**Nathaniel Chung**

Berrien County Math & Science Center

This science project looked at the affects of amino acid supplementation on cancer growth I took cancer cells and grew them in the normal solution they usually grow in. However, instead of just growing the cells inside of the solution itself, I supplemented varying percentages for amino acids Trptophane and Methionine. I supplemented percentages 0.1, 0.01, and 0.001 of both amino acids and measured the amount of growth the cells exhibited. The cell count was measured by a fluometer, which is a device that emits a particular light frequency to the cells and observes the fluorescence the cells gives off. This experiment attempted to observe the affects of dietary protein on cancer growth, since testing was performed using rare amino acids, which can only be sourced from foods.

I was inspired to research this topic after witnessing my grandfather, who was diagnosed with terminal cancer, outlive his deadline and continue to live to this day. Remarkably, his therapy and treatment did not contain any chemotherapy, and, instead focused on providing the best nutrition to his body to fight off the disease. I hoped to actually perform an experiment that had some raw data for this way of combating cancer.

My results exhibited a positive increase in growth when amino acids were available to the cells. I observed a great increases in the number of cells when more amino acids were given. This certainly shows that an increase in protein causes cancer cells to grow faster and greater. However, a rather different deduction that can be taken from this project is that a restriction of rare amino acids, or dietary protein could possibly stall cancer growth. This is not directly proven, but a restriction in rare amino acids, or protein sourced from diet, would at least cause the cancer growth to be less accelerated than if there was an abundance of protein. I would highly recommend it based on my projects results.

## *Synthesis and Anticancer Activity of Chalcone Ureas*

**Cameron Ekanayake**

Berrien County Math & Science Center

The goal of this project is to synthesize chalcone ureas and test for anticancer activity in breast cancer cells. The chalcone ureas were prepared in a two-step process that involved the synthesis of butyl ureas from 4-aminoacetophenone followed by reactions with ten different aldehydes. The ten, unique resulting chalcone ureas were then tested on breast cancer cell lines using 96 well plates at four different dilutions. It was seen that at all four dilutions, specifically at the 0.1 mg/ml dilution, showed increased cancer activity.

## *Synthesis and Insecticidal Properties of Glycine Betaine Esters*

**Derrick Ekanayake**

Berrien County Math & Science Center

The purpose of this project is to synthesize and test the antibacterial properties of Glycine Betaine esters. Through a chemistry based process Glycine Betaine was synthesized with different organic halides. An IR machine was used to help determine if the products were synthesized correctly or not. The successful (conclusive) products are shown below:

- 1-bromooctane
- 1-bromododecane
- 1, 4 Dibromobutane
- Dichloro-m-xylene

In the biology aspect of the experiment products were tested for antibacterial properties with a gram-negative bacteria known as serratia. Only two were tested with serratia and both showed antibacterial properties. 1-bromooctane compound showed moderate antibacterial effects in few dilutions whereas the 1-bromododecane compound showed extremely high levels of antibacterial properties by decreasing cell viability in all dilutions.

## *Synthesis and Anticancer Properties of Boronic Acid Substituted Curcuminoids*

**Samantha Ekanayake**

Berrien County Math & Science Center

The aim of this research project was to synthesize a hybrid drug that would display magnified anticancer properties on breast cancer cells. This will be done with the synthesis of symmetrical boronic acid substituted curcuminoids. So far, there is only one anticancer drug on the market that contains boronic acid. However, since both curcumin and boronic acid display anticancer properties individually, it is vital to test the potential of these compounds as a synthesized hybrid drug. The experimental methods of reflux and vacuum filtration were used in the synthesis of these compounds and, through this process, six different products were formed. Of these six compounds, infrared spectroscopy (IR) analysis confirmed the product structures of five compounds. During the biological portion of this experiment, three of the six compounds (4-formylphenylboronic acid curcuminoid, 2-formylphenylboronic acid, and 2-fluoro-4-formylphenylboronic acid) were tested on breast cancer cells (AU565 Her 2/neu).

The results of these experiments displayed positive results, with two of the three tested products with confirmed IR successfully reducing cancer cell viability in breast cancer cells. The 4-formylphenylboronic Acid Curcuminoid proved to be the most potent in decreasing cancer cell viability, with the drug reducing the cells in all four dilutions (0.2 mg/ml, 0.1 mg/ml, 0.02 mg/ml, and 0.01 mg/ml). Thus, this study shows the probable potential of the use of symmetrical boronic acid substituted curcuminoids as a hybrid drug for cancer. Additionally, future work can be done to further the research of this experiment by taking the NMR of the products, testing all compounds that were synthesized for anticancer properties, and synthesizing more boronic acid based curcuminoids.

## *Synthesis and Anticancer of Phenolic Aurones*

**Alena Flegel**

Berrien County Math & Science Center

The purpose of this research project was to synthesize and study the anticancer activity of aurones. The goal was to create a product that kills breast cancer cells. In order to synthesize aurones, 3-coumaranone was combined with phenolic and boronic acid groups through refluxing, vacuum filtering and pouring the reaction into a beaker with ice. The product was collected and weighed. The IR was taken to confirm the structure of the products. 4 products were tested against breast cancer cells. The products were combined with DMSO and 4 dilutions were made. A 96-welled plate was set up and the media and cells were combined to form the control. Three wells were set up for each dilution to average out the results and get the general effectiveness of each product. After a day of putting the product in the wells, 40  $\mu$ l of cell titer blue was added to test the fluorescence and see how many cells were left in each well. The products of 2- and 3-formylphenylboronic acids both showed a significant decrease in breast cancer cells whereas 4-formylphenylboronic acid showed an increase in cells. This implies that the position of the R-group might have an effect on whether or not a product is anticancerous.

## *Synthesis and Sensing Capabilities of Azo Thiobarbiturates*

**Toby Fox**

Berrien County Math & Science Center

In this research, I will try to create an azo thiobarbiturate molecular sensor that will react and change color with the presence of metals. To do this I will combine thiobarbituric acid with nitric acid and a primary aromatic amine to create an azo bond between the two. An azo is characterized by a nitrogen-nitrogen double bond. Azos are found in many dyes. All together, I created 16 different azo thiobarbiturate molecular sensors. Some of the percent yields were low compared to the theoretical yields. Future work would include testing these products in different solutions that contain metals to see if these products would react and change colors in these solutions. Students at Andrews University are conducting similar research that may show other more results in research.

## *Synthesis and Cell Agglutination Properties of Boronic Acid Substituted Triesters*

**Madelaine Gelesko**

Berrien County Math & Science Center

For my project, I am working towards the synthesis and bacterial agglutination properties of tris-boronic acid triesters. My overall goal for my project is to be able to cell agglutinate tris-boronic triesters. In other words, I want to be able to find a molecule that is able to agglutinate three cells of bacteria. Throughout my experiments, I created agglutinators using both trimesic and citric acid, with different bromomethyl phenylboronic acids. I used benzyl chloride in creating my controls.

Out of the 8 experiments that were conducted, 8 products were formed. The IR was taken for all products, however while experiment numbers 2, 3, 4, 5, 6, and 7 were successful, 1 was not, and 8 was inconclusive. When creating solutions in Biology, although 8 solutions were formed, not all fully corresponded with the 8 products made in Chemistry. Only 6 out of the 8 solutions in Biology were tested. Only ones involving trimesic acid were active, while citric were inactive. After testing in bacteria, when agglutination was shown, only three dilutions worked. The most effective product, being product 4, Trimesic acid with 3-bromomethyl phenylboronic acid, worked at three concentrations, decreasing with increasing dilutions. Non-boronic products were slightly better at no dilution, but worse than boronic-containing at lower concentrations. If to continue these procedures I would do four main things, these being, use different vials in Biology, optimize the synthesis of tris BAT, (tris-boronic acid triesters), test the other tris BAT compounds, test a variety of both gram-positive and gram-negative bacteria.

## *Synthesis and Anticancer Activity of $\alpha$ -Chlorosulfamate Ureas*

**Joseph Hess III**

Berrien County Math & Science Center

The goal of this research is to synthesize  $\alpha$ -chlorosulfamate and ureas in order to create a hybrid drug and research its anti-cancer effects. During the synthesis of the compounds, there were four reactions which made four different products. For simplistic reasons these products will be labeled products 1, 2, 3 and 4. All products were confirmed through the infrared spectroscopy instrument. I tested all four of the products that were created. Products 1 and 2, at all dilutions, 0.01 mg/ mL 0.02 mg/mL, 0.1 mg/mL, and 0.2 mg/mL exhibited anti-cancer properties that reduced the cancer cell count. Products 3 and 4 showed cell growth at all dilutions. Based on the data collected in this experiment, certain modifications of  $\alpha$ -chlorosulfamate ureas seem to have anticancer properties.

## *Synthesis and Hemagglutination Properties of Boronic Acid Substituted $\alpha$ -Amino Esters*

**Brooke Janes**

Berrien County Math & Science Center

This study observed the effects of guanidino boronic acids on the agglutination of blood. Guanidine amino acids were combined with boronic acids and then tested on cleaned human red blood cells. We predicted that these boronic acid-amino acid molecules would bind to the cells, forming a link between them and creating agglutination. The compounds were first formed using different amino acids as well as different boronic acids. A positive blood cells were then cleaned and combined with the products for observation of agglutination. However, only one of the products formed correctly, and only two were observed to have caused agglutination.

## *Synthesis and Metal Sensing Properties of $\alpha$ -Cyanoazastilbenes*

**Alex Jasper**

Berrien County Math & Science Center

The goal of this research is the synthesis of  $\alpha$ -cyanoazastilbene sensors for toxic metal ions. After the synthesis has taken place, an evaluation of the optical responses given off by the sensor will be investigated. For a sensor to be successful, it must do two things: Recognize and Respond. It first has to "recognize" that what you wish to detect is present, and then "respond" by giving off a signal, such as fluorescence, or a color change. Previous sensors have been created to determine dangerous toxins. The outcome of my research is to create a sensor that will recognize and respond to metal ions such as chromium, nickel, cobalt, and copper. I believe that certain  $\alpha$ -cyanoazastilbene sensors will respond to metal ions more efficiently than others. Molecular sensors, such as the ones I will be creating, are nondestructive and have more convenient applications. Most of those sensors can distinguish between  $\text{Fe}^{2+}$  and  $\text{Fe}^{3+}$  as well as  $\text{Hg}^+$  and  $\text{Hg}^{2+}$ . A few of the sensors can also determine when  $\text{Al}^{3+}$  is present.

## *Synthesis and Insecticidal Properties of Cyclized Citronellal Derivatives*

**Lillian Jillson**

Berrien County Math & Science Center

The synthesis of cyclized derivatives of citronellal was performed as well as testing. By reacting an acid chloride with citronellal, an ester should appear and an aldehyde and acid chloride should disappear. These will demonstrate an example of electrophilic carbonyl addition followed by cyclization. These also should produce an aroma that repels insects. After synthesis, the products were arranged to be tested on mosquitoes, nematodes, and fruit flies. The insects were placed in containers with the product to analyze how the products affect their ability to survive. Many were unable to be tested, but upon testing, all synthesized reactions failed to repel or kill insects.

## *Synthesis and Metal Ion Sensing Properties of Azoimines*

**Jacob Kanaby**

Berrien County Math & Science Center

The human body is full of metal ions, such as magnesium, copper, zinc, and iron. These metals play a huge role in a number of processes that take place within the human body. For example, calcium strengthens bones and also plays a role in muscle, nerve function and blood clotting. Molecular sensors can monitor specific metal ions in the body and can detect when these levels are abnormal. The human body isn't the only place where these metal ions are found, they exist biologically as well. So, the role of metal sensors is instrumental in detecting diseases in humans and abnormalities in the environment. In this experiment, an azoimine was created and combined with different metal ions in hope that there would be a detection and spectroscopic change in the azoimine. Based on the IR results, we successfully created seven azoimines. Unfortunately there were no signs of a fluorescence change when the azo sensors reacted any of the metals or Lewis Acids.

## *Randomness in Internet Security*

**Michael Kaufmann**

Berrien County Math & Science Center

During this research experiment, I tried to produce true random number generators that are capable of replacing pseudo-random number generators. I started by drawing flowcharts of each program, then coding two programs to produce random numbers based on the flowcharts: one from audio input, and the other from keyboard input. The program from keyboard input ended up using ASCII codes, and the audio input program read binary data from .wav files. Next, I gathered one thousand digits ranging in value from one to ten from each program. I graphed this data to look for trends in frequency. Each graph looked completely different, but this is expected because the data is random. All of the graphs displayed the expected frequency of each digit, so they each produced numbers with the correct distribution. Then, I tested to make sure that these programs produced sequences that were equally random by comparing them with a pseudo-random constant. With the T-Tests proving that there is not a significance between data distribution (they each had a p-value greater than 0.05) the data can be assumed equally random. The sequences were determined random, so the sequences could be used in the place of pseudo-random number generators. Because the true random number generators are not reproducible, the data they encrypt is safer than if a pseudo-random number generator is used.

## *Synthesis and Properties of Enhanced Chitosan-Based Hemagglutinators*

**Donovan McPherson**

Berrien County Math & Science Center

The idea behind this project was to synthesize Boronic Acid Appendaged Chitosan and test its agglutination properties. The thought is that by combining chitosan, a natural agglutinator and polymer, and boronic acid, another substance used for agglutination, a "super agglutinator" can be achieved. Chitosan is a material that comes from chitin, or crustacean shells, mixed with an alkaline substance. Chitosan is already being used in bandages as an agglutinator. Boronic acid also is on a similar path. There is a lot of research containing boronic acid and utilizing its ability to detect carbohydrates. By combining the two natural agglutinators it may be possible to obtain a "super agglutinator." Using reductive amination, the boronic acid was attached to chitosan. The product was tested on sheep and human blood. The sheep blood coagulated, not agglutinated. The enhanced chitosan was found to have agglutination properties on O positive, but was more often found to cause the blood to hemolyze. This hemolysis is inconclusive to whether the products are agglutinating or not.

## *Synthesis and Anticancer Activity of Phenolic Arylidene Rhodanines*

**Reagan Nadai**

Berrien County Math & Science Center

This research project dealt with synthesizing phenolic arylidene rhodanine derivatives and then testing their anticancer effects on breast cancer cell lines. We were curious about the presence and position of the hydroxyl (OH) group and its effect on cancer cells, so we chose to combine rhodanine with aldehydes. These various aldehydes were synthesized with rhodanine to create 13 different product compounds. Three of these product compounds (2-formylphenylboronic acid, 3-formylphenylboronic acid, and 4-formylphenylboronic acid) were tested on the breast cancer cell lines. Solutions were made from the products, which were then used to make four dilutions for each product (0.2 mg/ml, 0.1 mg/ml, 0.02 mg/ml, and 0.01 mg/ml). 2-formylphenylboronic acid and 3-formylphenylboronic acid displayed anticancer properties in all four dilutions. 4-formylphenylboronic acid showed anticancer properties in the 0.02 mg/ml and 0.01 mg/ml dilutions but displayed no effect on killing the cancer cells in the larger two dilutions. The information taken from this research can be used to further research the efficacy of phenolic arylidene rhodanines on cancer cells.

## *Synthesis and Insecticidal Activities of Indanol Derivatives*

**Greg Olsen**

Berrien County Math & Science Center

The purpose of this research is to investigate the insecticidal activities of indanol derivatives. Indane is already effective in antimicrobial and antiviral capacities, and researching its effectiveness as an insecticide combined with acyl chlorides could lead to an added utilization of the molecule. Insecticides today pose a threat to the environment and surrounding ecosystems because they carry toxicity. Commonly used organophosphates and carbamates disable the enzyme acetylcholinesterase in the insect's nervous system. However, organophosphates and carbamates harm the environment and mammals. Esters are a more 'green' and environmentally friendly solution to the insecticide problem. By a two step process of electrophilic carbonyl addition and cyclization, hydrocinnamaldehyde is combined with an acyl chloride, with a by product of hydrochloric acid. The resulting compound will hopefully be effective against drosophila (fruit flies). Indanol derivatives can have an effective application as insecticides.

## *Synthesis and Properties of Novel Diquaternary Ammonium Salts*

**Hannah Olson**

Berrien County Math & Science Center

This purpose of this project was to create a new transfecting reagent. We did this by synthesizing diquaternary ammonium salts and boronic acids. Once these products were created, we tested them on breast cancer cells to see if they exhibited transfection properties. To see if the experiment was a success, we looked at the cancer cells under a UV light to see if they were fluorescent. If the cells were fluorescent, it means that the transfection of a fluorescent protein into the cell was successful. We had three products that were successful transfectors. Two did not work as well as the control. The control is a transfecting reagent currently on the market. However, we had one product that worked better than the control.

## *Synthesis and Sensing Capabilities of Bidentate Azastilbenes*

**Brynn Ritchey**

Berrien County Math & Science Center

Azastilbenes are useful as a sensor because a nitrogen attached to one of the benzene rings acts as a recognition site for detecting analytes. Bidentate Azastilbenes are a more efficient way to sense metals using a combination of nitrogen qualities with a pacman-like structures. The first step of my procedure worked according to the IR, but there was never enough produced to use for step two. The whole year was spent eliminating possible combinations of procedures, bases, and catalysts. Even though yields were low, IR results gave us the ability to say with confidence that we had created dipyrindyl sulfide, just not very much of it. We were also able to conclude that water was very effective when added as the major solvent and potassium carbonate was the only useful base that we tried

## *Synthesis and Biological Applications of Liquid Crystalline Luminol Amides*

**Vanya Ruppert**

Berrien County Math & Science Center

The purpose of this research was to synthesize liquid crystalline luminol amides (LCLAs) that would either extend the chemiluminescence duration or diminish false positive readings of luminol. I created LCLAs by a reaction of luminol with long chain carboxylic acids to produce six LCLA compounds. I tested the LCLA chemiluminescence using a known experiment: "The Chemiluminescence of Luminol" by Declan Fleming to determine the duration of chemiluminescence. After synthesizing and testing the chemiluminescence chemically, came the testing to determine if the liquid crystalline products react differently with biological samples than luminol. At the end of my project, LCLAs were successfully prepared based on IR analysis. LCLAs showed different chemiluminescence behaviour compared to luminol and to each other. Oxygenated LCLAs had shorter CL duration; fluorinated LCLA had longer CL duration. The LCLAs showed no major difference from luminol in CL testing of biological samples.

## *Synthesis and Staining Properties Liquid Crystalline Martius Yellow*

**Joonwon Seo**

Berrien County Math & Science Center

The purpose of my research project was to synthesize liquid crystalline Martius Yellow through reacting Martius Yellow with different kinds of long chain alkyl halides. Martius Yellow is a synthetic dye used to differentiate the coloration between red blood cells and red fibrin (a protein involved with the clotting of blood) by staining the red blood cells yellow. Longer chains gave better and stronger staining of hair, finger nail, or skin. In all three cases, hexadecyl (the longest of the chains) Martius Yellow stained more effectively than butyl (the shortest of the chains) Martius Yellow.

## *Synthesis and Insecticidal Properties of Rare Cyclic Organic Carbonates*

**Alex Shellhamer**

Berrien County Math & Science Center

The following paper describes the attempted synthesis of a rare cyclic organic carbonate known as "4H-1, 3-benzodioxin-2-ones," as well as eight other products formed through the substitution of various aldehydes into the experimental process. The two goals of this synthesis were to create a new way to make this specific product with higher yields, as well as to create a new hybrid pesticide out of two reagents that possess pesticidal properties. Of the nine products, eight reactions were successful (as indicated by results obtained from analyzing atomic spectra produced by an Infrared Spectroscopy machine). Four of the nine products were then biologically tested on fruit flies for pesticidal properties, where it was determined that none of those tested significantly affected the longevity of the flies. The combination of low yields and ineffective pesticidal properties unfortunately means that the two aforementioned goals were not met.

## *Synthesis and Carbohydrate Sensing Properties of Boronic Acid Azoimines*

**Taylor Sobolewski**

Berrien County Math & Science Center

This research project dealt with the synthesis and carbohydrate sensing properties of boronic acid azoimines and testing their detective qualities on sugars like glucose. We were eager to investigate the presence of carbohydrates using an azoimine structured sensor. In doing so we created five different imines. Three were successful and later combined with 3-aminophenylboronic acid and 4-aminophenylboronic acid to create five azoimines. Next, test solutions were created including five sensor, five base, and four analyte solutions. Every possible combination of these three types of solutions were tested, over one hundred twenty vials were used! There was not a sufficient amount of dramatic color change seen by the naked eye. However, when a color change occurred sensor two, or the p-chloroaniline imine and 4-aminophenylboronic acid combined as an azoimine, was responsible. The data retrieved from this research can be used to further future research on boronic acid azoimine sensors.

## *Synthesis and Antibacterial Properties of Glycine Betaine Chloro Acylals*

**Madeline Stanton**

Berrien County Math & Science Center

The purpose of this research was to synthesize then determine the levels of the antibacterial properties of glycine betaine chloro acylals, if there were any to report. These results were compared with those found by Derrick Ekanayake, who is following the same testing procedures using glycine ester. Glycine ester has a chemical structure that is very close in nature to the glycine betaine chloro acylals that were synthesized and tested.

The structures of these products were determined by an IR instrument. With comparison to the organic starting reagents, these products seem to be correct except for p-Tolualdehyde. They were tested using *E. coli* and *Serratia* bacteria, both of which are gram negative. For the chloro acylals, all the products worked with the *E. coli* except for the p-Tolualdehyde and propanal. The *Serratia* had similar findings with only p-Tolualdehyde and dodecanal not working as antibacterials.

Out of all of Derrick Ekanayake's glycine betaine esters, bromododecane was the most comparable to the dodecanal glycine betaine chloro acylal. Due to time constraints, the bromododecane was only able to be evaluated using *Serratia*. In this trial, the bromododecane was far more effective, with dilutions as low as 1:100 working with great efficiency. The dodecanal did not have any significant antibacterial properties on the *Serratia*.

## *Synthesis and Sensing Capabilities of Arylidene Thiobarbiturates*

**Alexandra Tobler**

Berrien County Math & Science Center

The goal of my research is to synthesize and test arylidene thiobarbiturates as potential sensors for metal ions. After the synthesis and research is done with the reactions, I will be looking at visual color change with the metal ions. Thiobarbiturates have been previously reported to act as fluorescent sensors with different metal ions, such as gold. I will not be using gold, but the following ions were used in my study:  $\text{Cu}^{2+}$ ,  $\text{Cu}^{+}$ ,  $\text{Pb}^{2+}$ ,  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{Al}^{3+}$ ,  $\text{Hg}^{+}$ ,  $\text{Hg}^{2+}$ ,  $\text{Ag}^{+}$ ,  $\text{Fe}^{2+}$ , and  $\text{Fe}^{3+}$ . My hypothesis is that the arylidene thiobarbiturates will show a color change to determine that a metal ion is present. I will be using the metals listed above with 13 different benzaldehydes for my reactions. For the first part, I will synthesize my products by combining the benzaldehyde and thiobarbituric acid through reflux and vacuum filtration. For the second part I will be mixing and analyzing the combination of the benzaldehyde product and the metal ions listed above. I will be looking for a color change and the results were that  $\text{Fe}^{2+}$  and  $\text{Fe}^{3+}$  produced the best color change of yellow to brown. The best sensors were produced from: 2,4-dihydroxybenzaldehyde and 3,4-dihydroxy-5-nitrobenzaldehyde. I hope to eventually make a solution that could detect metals on fish or soil.

## *Synthesis and Insecticidal Properties of Novel Benzooxaheptalactones*

**Chris Wentworth**

Berrien County Math & Science Center

Lactones possess qualities that allow them to be used in everything from flavorings to parasite medications, and the less common, medium-sized compounds in the lactone family may have potential uses in these and other areas. Novel methods of production, such as the use of aldehyde addition and carbonyl cyclization, have the potential to greatly increase opportunities for the use of seven membered lactones in research. This two-step process has achieved yields averaging about eighty percent, and IR test results indicate that synthesis was successful. Results of product testing on drosophila were inconclusive, however results from testing on nematodes were promising. This shows that benzooxaheptalactones may have some antiparasitic qualities.



## 2018 PSA Presentations

Audrey Bakerson, Jacob Carew, Anna Cleveland, Hannah Coles, Brandon Feole, Nathan Gustafson,  
Connor Janowiak, Brighton Lee, Kadin Mills, Aaron Rodgers, Maeli Rogers and Jae Won Seo  
*Berrien County Math & Science Center*

## 2018 Poster Presentations

Hannah Ahmed	The Development of Novel Cyclic Transfecting Agents
Daniel Arn	Synthesis and Sensing Capabilities of Azachalcone Oximes
Audrey Bakerson	Using Urine and Saliva Solutions in a Capillary Tube Precipitation Test to Detect Dust and Dander Allergens in IgE Sensitized Individuals: A New Non-Intrusive Antigen/Antibody Reaction Test
Olivia Bella	Synthesis and Hemagglutination Properties of Boronic Acid Modified Glucosamine
Kelly Bickel	Synthesis and Antibacterial Activity of Boronic Acid Substituted Penicillins
Emily Branch	Synthesis and Anticancer Activity of Indole- $\alpha$ -Cyanostilbene
Everett Case	Development of Nile Blue A Liquid Crystals as Potential Sensors for Date Rape Drugs
Robert Clark	Synthesis and Antifungal Activity of Biodegradable Quaternary Ammonium Acylals
Matthew Davis	Azo-Indophenol Sensors for Vitamin C
Logan Edwards	Testing of Chemical Compounds as Potential Pesticides
Collin Esarey	Synthesis and Sensing Properties of Azooximes
Micah Gamble	Using Statistical Modeling to Predict the Outcomes of March Madness
Matthew Gremaux	Synthesis and Biological Activity of Novel Formazan Tetrazoliums
Jared Hailey	Synthesis and Biological Applications of Liquid Crystalline Nile Blue A Amides
Matthew Harazin	Synthesis and Sensor Applications of Liquid Crystalline Dichlorofluorescein Esters
Elizabeth Hartz	Synthesis and Anti-Cancer Activity of Heterocyclic Boronic Acid Substituted $\alpha$ -Cyanostilbenes

## 2018 Poster Presentations

Samantha Hildebrand	Synthesis and Anticancer Activity of Fatty Acylureas
Marcus Hurt	Synthesis and Sensor Application of Liquid Crystalline Eosin Y Esters
Alec Janowski	Effect of Boronic Acid Appendages on Chitosan Hemagglutination Properties
Cecily Kaufmann	Synthesis and Anticancer Activity of Quinoline $\alpha$ -Cyanostilbenes
Noah Khanfar	The Music of Chaos
Aidan McKiernan	Air Resistance is a Drag
Conor McKiernan	Synthesis and Biological Applications of Liquid Crystalline Azure A Amides
Erica Mitchell	Synthesis and Antiparasitic Properties of Rare Benzooxahaheptalactones
Kaylee Moore	Development of Colorimetric Sensing Method for Vitamin C
Matthew Norris	Synthesis and Applications of Sudan II Carbamates
Jasmine Sindelar	Development of Novel Acyclic Tris-Quat and Quat-Quat Transfecting Agents
Kailey Skarbek	Synthesis and Biological Applications of Liquid Crystalline Martius Yellow
Luke Smous	Development of Novel Acyclic Bis-Quat Transfecting Agents
Brandon Strickland	Synthesis and Anticancer Activity of Arylidene Pyrazolones
Megan Wieger	Heterocyclic Arylidene Chemical Compounds vs. Glioblastoma
Brianna Wright	Synthesis and Antibacterial Activity of Phenolic Azo Drugs

# 2018 Research Presentations

## *The Power-Hungry Halo Effect*

**Javeria Asif and Ankita Singh**

Battle Creek Math and Science Center

The Halo Effect is the behavior of unconsciously using evaluations, built upon perceptions unrelated, to form judgements about an object or a person. The purpose of this project was to determine if a person's choices and preferences would remain the same, or if the addition of a halo effect would overshadow their initial picks. This question was administered through the surveying of thirty-four students for their preferences in terms of apple likability. Two surveys were carried out—one with the general preference (students were unaware of the type of apple) and the other with the halo effect introduced (wording bias). Corresponding pH levels and sugar contents of the different varieties of apples were also determined in order to see if there is a statistical significance between the two variables and preferability.

## *Elucidating Pressure's Impact on Performance*

**Matthew Baker and Hannah Emch**

Williamston High School

The purpose of this research is to evaluate the impact pressure has on performance, namely in academics and athletics. Pressure was applied by using three forms: observational, monetary, and timed pressure. The results were gathered from five studies, two centering on academics, testing math and recall among Williamston High School students, and the other three studies focused on athletics, using basketball and golf. The results were compared by using either a 2-Sample t-Test or a Matched Pairs t-Test, depending on appropriateness, that calculated the p-value to determine whether or not the results were significant using a p-value of .05. After conducting the tests for the basketball free throw, basic math test, word association, golf, and basketball three pointer studies, the p-values .6818, .0101, .7474, .7619, and .2195, respectively, were found. The results from the five tests demonstrated that performance was not altered by the varying methods of pressure, disproving the hypothesis that pressure would have a negative impact on performance.

## *The Role Of Oxidized Phospholipids in Heart Disease*

**Jadon Clugston, Kenneth Petto & Nathan Piersma**

Otsego High School

Cardiovascular disease is the number one cause of death in the United States and coronary artery disease (CAD) is the most common type, causing 370,000 deaths annually. CAD manifests itself through atherosclerosis, the process of a calcified fatty streak forming in the inner lining of the coronary arteries, restricting the passage of oxygenated blood to the heart muscle, which may cause a heart attack. The main focus of research is the stimulation of the endothelial cells by low density lipoprotein (LDL) after it is oxidized within the artery wall. This changes gene expression in the endothelial cells, resulting in the increased recruitment of monocytes. Monocytes in the tunica intima layer can become engorged with LDL and turn into foam cells, which build up underneath the endothelial layer, causing the calcified fatty streak.

To simulate this process, donated human endothelial cells are grown in the lab, sustained with FPS, and cleaned using a phosphate buffer solution for cultivation before treatment with oxidized phospholipids that are also synthesized in the lab. The phospholipids used are oxidized by direct oxygen exposure after being dried to the bottom of a test tube. These oxidized phospholipid samples are then measured and monitored with mass spectrometry in order to optimize the amount of specific lipid needed and standardize the properties of all samples. Experiments are done to measure the amount of monocyte binding after exposure to oxidized phospholipids relative to the length of exposure and biological volatility or

reactivity of the phospholipid components in question. Techniques such as western blotting and polymerase chain reaction (PCR) are then used to measure gene expression in cells both treated and untreated with oxidized phospholipids while computer imaging programs count and display the amount of monocytes recruited. Possible outcomes of this research could include the development of pharmaceuticals that decrease the risk of atherosclerosis and an increased understanding of the fundamental dangers and biological processes involved.

### *The Personalities Behind the BCAMSC Community*

**Diana Dalski**

Battle Creek Math and Science Center

In this study, the results of the Myers-Briggs test for BCAMSC students were analyzed; specifically, the category of Intuitive versus Sensing. The hypothesis of this study was that a higher percentage of BCAMSC students would be Intuitive instead of Sensing. A random sample of students from each grade at BCAMSC were selected and given the Myers-Briggs test. The information was sorted and analyzed using statistical tests to see if there was a significant difference between the global averages and the BCAMSC averages.

### *The Feasibility of Implementing Biosand Filters to Recycle Water in a School Environment*

**Alexa Eby and Tia Tiedje**

Williamston High School

The Biosand Filter is a widely used slow sand water filtration system used in developing countries. The filter works through the use of a biological layer to kill pathogens in the water. The focus of this research was to determine the effectiveness of a Biosand Filter to clean greywater from handwashing to be recycled, as well as the feasibility of using a Biosand Filter to recycle water in a school. River water was put through the filter daily to build the biological layer. Bacterial samples showed the biological layer took six weeks to grow resulting in filtered river water having the same number of small bacterial colonies as school water. The newly filtered water was placed into a female's bathroom and used as hand washing water. Collected hand washing greywater contained a high concentration of all natural soap that the biological layer was unable to process. The number of female students who used the bathroom was collected to determine the water usage of female bathrooms. Data collected on female bathroom usage found that the females' bathroom sinks used 6.7% of the school water, resulting in an average of \$8.44 water cost with a \$10.62 sewer charge over a 2-month period.

Ultimately, implementing Biosand Filters in a female bathroom using recycled river water is feasible. However, it would not be feasible to recycle greywater due to the soap harming the biological layer, and the inability to recycle greywater results in a sewer cost greater than the cost of the water itself, making the Biosand Filter financially unprofitable.

## *Harvesting Kinetic Energy Through Linear Alternation*

**Max Eyster, Lochlyn Reed & Seth Woodbury**

Williamston High School

The focus of this research was to harness human kinetics as an alternative energy source. Two body parts (shoulder and calf) of 20 randomly selected subjects were tested with a modified accelerometer that measured movement in all three dimensions which ultimately concluded the calf generates the most movement. A linear alternator was created to fit on the calf and utilize its movement. Designed to employ Faraday's Law of Electromagnetic Induction, a neodymium magnet was elastically suspended inside of a pipe wrapped with magnet wire. Thus, any movement involving the calf, such as a step, moved the magnet vertically through the magnetic field generating minute amounts of electricity in the coil that traveled through a simple circuit with a bridge rectifier changing the state of the current from AC to DC before going on to charge a lithium ion battery. The prototype battery, connected to a USB, could power most electronic device that has USB charging capabilities.

The energy generated by the prototype was measured in the seconds that the lithium ion battery took to charge an Iphone X. Forty-six independent trials were performed, where a trial consisted of a subject wearing the prototype around their dominant leg for a set amount of time before the prototype was removed and an Iphone X was plugged into the prototype battery while the time it took for the battery to fully discharge was measured and recorded. Forty trials, 20 trials for two different subjects, were performed using a two hour interval. A 2 sample t-test for difference of means was calculated failing to provide significant evidence ( $p=.9460864317$ ) that the prototype discharge time differed for each subject providing justification to pool all the data. A median discharge time of 75.85 seconds was calculated from the two hour interval trials, and a strong positive linear relationship ( $r=.9787701852$ ) was found between hours of prototype use and seconds it takes for the battery to fully discharge into an Iphone X, increasing by an average of 40.63130779 seconds per hour. Electromagnetic Induction as a sole power source driven by human kinetics is a relatively untapped idea and although its relative inefficiency is present when given the difficult task of charging an Iphone X, future research could prove it to be quite effective when tasked with powering devices with lower voltage inputs.

## *Analyzing Academic and Behavioral Implications of Robotics in Elementary Classrooms*

**Abby Foss and Caitlin Wilcoxon**

Williamston High School

In today's workforce there is a shortage of professionals entering Science, Technology, Engineering, and Mathematical (STEM) careers, causing a so-called "STEM Epidemic". This has caused a rapid increase of STEM driven education initiatives to be implemented across the nation. Many have questioned how effective this is in increasing interest in STEM careers, altering students' attitudes towards STEM, as well as the impact on students' education as a whole. This study examined the direct impacts of implementing a robotics program in third grade classrooms; specifically focusing on the behavioral impacts, interest in STEM, increased participation, and finally the impact on students' grades. We hypothesized that behavior, participation, grades and scores (on tests we prepared) would all improve as a result of the robotics program we implemented. Matched Pairs t-tests were performed among all three sample groups in all categories tested by being given a pre and post exam before the study began and once the study was finished. With the first group ( $n=44$ ), our hypothesis was confirmed in both the math and engineering tests as our p-values were both less than .05 (math,  $5.84 \times 10^{-20}$ , engineering,  $2.172 \times 10^{-19}$ ). In both other classes ( $n=22$ ) and ( $n=22$ ), each had a p-value well below .05, representing a significant increase in their knowledge of the topics covered (math and engineering). Two of the three classes had increases in their math grades as well. Using a scale we designed ourselves, we evaluated the behavior and participation of each student before, during, and after the study, then rating them from a 1 to 5 in each category. We also performed Matched Pairs t-tests for behavior and participation, which showed improvement for both of these areas was significant. These results support our hypothesis that by implementing a robotics program in an elementary classroom, behavior, participation, and academics will all improve. Thus, the expansion of robotics programs in elementary classrooms should be explored.

## *Determining the Evolution of Groundwater Chemistry in Ingham County*

**Katey Hajdu & Katie Torra**

Williamston High School

This study's purpose was to determine how the water in Ingham County, Michigan has changed since it was last analyzed in 1986. From that study, the results indicated uncommon levels of chemicals in groundwater wells in the area. One of the most unique cases found was the naturally soft groundwater wells in Williamston, Michigan. During the course of this study, many of the same wells sampled in 1986 were sampled again, specifically in Williamston. Chemical analyses of the samples were conducted at Michigan State University, followed by statistical analyses of the resulting data. The Mann-Whitney U Test was chosen to test for significance in the changes due to not being normally distributed. Of the 16 parameters tested, 12 of them were significant in change. These results show that the groundwater quality in Ingham County has become more contaminated. They also suggest that there are unknown factors affecting the chemical makeup of the groundwater in Ingham County.

## *Analysis of the Evolution of Attractiveness using the Golden Ratio*

**Alyssa Hidalgo**

Williamston High School

For years, people have set out to find the most aesthetically pleasing ratio. Through nature, architecture, and the human body, researchers studied their histories and evolutions and determined that the golden ratio is the most pleasing. They took examples from Leonardo Da Vinci's 'perfect' human, the ancient buildings of the Roman Empire, and from humans today. They came to the conclusion that the ratios of all these revolved around the golden ratio. Yet, many are skeptical of this ratio and its supposed beauty traits. To end this controversy, this study looked at famous beauty icons through the decades to determine if the golden ratio was prevalent, and whether or not faces are becoming closer to, or further from, the golden ratio. To do this, a facial mapping program was developed, using C# and written in Visual Studio, to scan facial images and determine the ratio of the distances between their eyes and between the center of the mouth and the midpoint between their eyes. Once completed, a collection of 30 images, consisting of 15 males and 15 females, of the most popular beauty icons of every two decades from the 1920s to the present was run through the program. Following data collection, the averages for each decade were compared over time, as well as males compared to females. The results show that no decade is particularly close to the golden ratio, but rather all follow a smaller ratio, and that the ratio is decreasing over time for females, yet staying relatively consistent for males. Comparing the sexes, the popular male ratio was smaller than females in the early 20th century, yet the century ended with the roles reversed. The results indicate that the golden ratio is not the most prevalent in our society, and that we are actually shifting to favor a smaller ratio over time.

## *Tensile Strength Testing of Varied Twists in Clinch Knots*

**Dylan Moore and Josh Pawlowicz**

Battle Creek Math and Science Center

The most important thing in fishing is the attachment of the hook to the line. The typical way one would do so is by tying a clinch knot. There are multiple amounts of turns can be used to tie the knot, however. It can be assumed that the more turns used when tying the clinch knot, the more steadfast the line will be. With many turns, the knot will be stably attached to the hook. But, if one does not wish to spend as much time, only a few turns will be made before fishing begins, for it was believed that the amount of turns does not affect the outcome. This is what the project is trying to solve: to see whether the amount of turns used to make the clinch knot will affect the amount force the knot can hold before breaking, and by how much it will be affected.

## *Ameliorated Analysis Concerning Deferred Gratification Among Adolescents*

**Jared Rector**

Williamston High School

Walter Mischel led and conducted a series of studies concerning delayed gratification in the 1970s, using the local nursery and adults that the children were familiar with. These studies, later dubbed the Stanford Marshmallow Experiment, along with follow-up research concluded that those who possessed a greater ability to defer their gratification were more likely to succeed later in life (i.e. less likely to be obese, less likely to have debt, less likely to succumb to addictions, etc.). However, Mischel and his Stanford team overlooked factors proving to be detrimental to the results. This study examined the omitted factors to the greatest extent available without being overly invasive of privacy. Each student was classified as either male or female, then all eligible kindergarten students were randomly divided into four categories: individuals with both unfamiliar and familiar adult, and groups of two with both unfamiliar and familiar adults. Those students were then divided into subgroups of 4-6 per day individually and 4-6 pairs per day. The immediate reward was presented to the subject(s), available for attention while he or she waited. The student was then unknowingly monitored as they waited for the deferred reward (obtained after a waiting period of eight minutes).

The data collected was tested at an alpha level of 5%, with the null hypothesis stating that the two points of comparison are equal, and the alternative hypothesis rejecting that the two are equal. The null hypothesis is accepted only in the case of groups with an unfamiliar adult and a familiar adult. The data concludes that the null hypothesis must be rejected in the cases of: (1) individuals with an unfamiliar adult opposed to a familiar adult, (2) individuals opposed to groups, (3) subjects with an unfamiliar adult opposed to a familiar adult, (4) males with an unfamiliar adult opposed to a familiar adult, (5) females with an unfamiliar adult opposed to a familiar adult, (6) males opposed to females with both having an unfamiliar adult, (7) males opposed to females with both having a familiar adult, and (8) males opposed to females. These results show that there are significant differences between the number of student who deferred their gratification in the two categories under comparison, further solidifying that Mischel neglected crucial factors when conducting his studies.

## *A Quantitative Analysis of the Proliferation of Microplastics in Williamston's Waterways*

**Luke Schafer and Hudson Yu**

Williamston High School

One of the most concerning aspects of human progress is the spread of pollution. Microplastic pollution is only a small part of this issue, but a relevant one nevertheless. Plastic debris can disrupt marine ecosystems, spread contaminants and take years to naturally degrade. Our aim for this study was to establish an understanding of the scope of Williamston's microplastics problem, as well as to attempt to find the source of these plastics. To take samples, we used 4 sites throughout the Red Cedar in Williamston townships. Sites were chosen due to their proximity in relation to the boundary of the school district, making sure to choose samples both up and downstream of the Wastewater Treatment Plant. In analyzing our samples, we used an aspirator vacuum to filter the water we collected, left it in an incubator to dry for 48 hours, and counted microplastics under a microscope by systematically scanning through our gridded filter paper. We found a general trend of increasing concentrations of microplastics upstream to downstream, but we were not able to locate the source of Williamston's microplastics pollution. Originally, we hypothesized that the Williamston Wastewater Treatment plant was the primary contributor to Williamston's microplastics pollution, but could not find statistically sufficient evidence to confirm this theory. However, we are confident that had our team collected larger samples, our data likely would have confirmed our initial postulation.

*Change in Mycoremediation Efficiency of the fungi Pleurotus Ostreatus as a Result of Varying Quantities of Motor Oil*

**Brendon Trevorrow and Joan Welk**

Battle Creek Math and Science Center

The fungus *Pleurotus ostreatus*, also known as the pearl oyster mushroom, has been shown to have extra-cellular lignin-modifying enzymes with a low substrate-specificity, allowing them to degrade a wide range of toxic substances, such as petroleum oil, into less toxic substances such as water and carbon dioxide (Rhodes, 2014). This discovery has sparked interest regarding its applicability in real world situations such as introducing large amounts of the fungus at sites of high quantities of oil such as the sites of oil spills. However, before routes for mycoremediation of these toxic compounds can be explored, multiple factors must be analyzed. The fact that this species of fungus has the capability to degrade oil begets the question, does the fungus *Pleurotus ostreatus* perform mycoremediation at elevated efficiency levels at lower quantities of oil, and does mycoremediation efficiency, as a contrast, decrease when exposed to higher levels of oil? To solve this question, four samples were taken of the species and exposed to varying amounts of motor oil ranging from 0 milliliters (mL) (the control), 25 mL, 50 mL, and 100 mL in order to test the limitation of the fungus *Pleurotus ostreatus*. Although the data was inconclusive, it was shown that the sample with 100 mL of motor oil showed a decrease in percent change in mass, while the rest of the samples had an increase in mass; these results work counter to the principle discovered by other researchers which state that the amount of oil should decrease as the fungus degrades the oil (Kulshreshtha, Mathur, & Bhatnagar 2014).

# 2018 Poster Presentations

## *The Development of Novel Cyclic Transfecting Agents*

**Hannah Ahmed**

Berrien County Math & Science Center

Transfection is the process of deliberately introducing naked or purified nucleic acids into eukaryotic cells. In simple terms, it is the process of deliberately introducing DNA or RNA into cells. Transfection is a combination of two words: transfer and infect. The process of transfection allows for a numerous amount of applications. The use of transfection allows the determination of what parts of a gene in a eukaryote are responsible for regulating its expression. My project was development of novel cyclic transfecting agents. The goal of this project was to create cyclic transfecting agents that make "pores" in the cells for the DNA to be inserted into the nucleus of a cell synthetically. The compounds were combined with the Monster Green plasma. If it glowed under the UV light, it meant that we successfully created transfecting agents. Only two of my compounds produced cells that glowed: Triazonane combined with bromooctane, and triazonane combined with 2-bromomethylphenyl boronic acid .

## *Synthesis and Sensing Capabilities of Azachalcone Oximes*

**Daniel Arn**

Berrien County Math & Science Center

The purpose of this research is to synthesize azachalcone oxime and test it as a potential sensor for chemical warfare agents. Firstly, 2-acetylpyridine and 4-dimethylaminobenzaldehyde were reacted to form azachalcone. The azachalcone was then reacted with hydroxylamine to synthesize azachalcone oxime. Both azachalcone and azachalcone oxime were tested as potential sensors of toxic metal ions. The test results from the azachalcone oxime show that it is not an effective sensor. The azachalcone, however, results in varying colors, depending on the metal ion being added. Since the azachalcone provided the best sensor results it is a good candidate for further development to create a more selective chemical sensor. It also shows promise to be potentially developed into a fluorescent chemical sensor.

## *Using Urine and Saliva Solutions in a Capillary Tube Precipitation Test to Detect Dust and Dander Allergens in IgE Sensitized Individuals: A New Non-Intrusive Antigen/Antibody Reaction Test*

**Audrey Bakerson**

Berrien County Math & Science Center

The purpose of this research is to create a new non-intrusive allergy test, that is less expensive, more time efficient, and can provide an alternative for not only the general majority of patients, but also the elderly, young children, and at-risk people with lower immune systems. The trials involved eight participants (eight who provide saliva & five of those provided urine) that were either allergic to both cats and dogs, one or the other, or were not allergic to either. Along with that, two cats and three dogs provided fur that was then used to extract dander from, by either water or in another trial acetone. One milliliter of the antibody (saliva or urine) was put into a test tube followed up by one milliliter of the antigen (dander). This process was used from five of the trials and then the last four trials were used as a positive and negative control. This resulted in nine trials with 156 test tubes. Further research needs to be done on commercial antigen solutions and reaching maximum consistency. This research and further research can accomplish the goal of creating a safer alternative for patients to never have to come in contact with what they are allergic to during an allergy test.

## *Synthesis and Hemagglutination Properties of Boronic Acid Modified Glucosamine*

**Olivia Bella**

Berrien County Math & Science Center

The purpose of this project was to synthesize and study glucosamine when modified by boronic acid, acetic acid, heat, assorted reactants and solvents, and other experimental conditions. Reductive amination, the process of converting a primary amine to a secondary amine, was the experimental process used to conduct each procedure. There were three phases of experimental analysis: the reaction phase, in which the raw materials were analyzed and the reaction was created, the isolation phase, where the solution was derived and the product created, and the identification phase, in which the product is analyzed and compared to the raw materials. The results of the testing revealed that 2, 2, 2-trifluoroethanol and high amounts of dichloroethane produced the best percent yields and clearest products. In the future, biological testing may be made for better understanding of the project.

## *Synthesis and Antibacterial Activity of Boronic Acid Substituted Penicillins*

**Kelly Bickel**

Berrien County Math & Science Center

The goal of this research project is to combine 6-aminopenicillanic acid with different boronic acids in order to test which boronic acid when combined with 6-aminopenicillanic acid has the best antibacterial capabilities/properties. This was done through various experiments consisting of stirring, extraction, refluxing, and a high vacuum line. After twelve experiments, we had a total of fourteen compounds, five of which we chose to dilute and test their antibacterial capabilities/properties. These five were Procedure 1- Benzyl Chloride, Procedure 2- 4-(Bromomethyl) phenylboronic acid Product #1, Procedure 2- 4-(Bromomethyl) phenylboronic acid Product #2, Procedure 3- 2-(Bromomethyl) phenylboronic acid, and Procedure 3- 3-(Bromomethyl) phenylboronic acid. After testing we lastly analyzed the zone of inhibition with each Procedure as well as a different amount of mg for each compound.

## *Synthesis and Anticancer Activity of Indole-alpha-Cyanostilbene*

**Emily Branch**

Berrien County Math & Science Center

The goal of this project is to synthesize indole-alpha-cyanostilbenes, anti-cancer, with the objective being able to help prevent breast cancer. The reagents that worked best were indole-3-carbaldehyde and (2-benzimidazolyl)acetonitrile, with alpha-cyanostilbenes as the product. The target molecules are hybrids containing indole on a stilbene/cyanostilbene structure. Some studies have found indole in certain vegetables (such as cauliflower and broccoli) while cyanostilbenes have been found in wine. In chemistry multiple products created from various reagents were produced; originally the project started off with indole-3-acetonitrile, but later on it was switched to indole-3-carbaldehyde due to its better yield results. This reagent along with (2-benzimidazolyl)acetonitrile worked the best in terms of IR and NMR, as the aldehyde group in the product's NMR decreased significantly. In an attempt to eliminate the aldehyde group completely the same project was run again twice, but with a 6 hour reflux and another with a 24 hour reflux. These three compounds were then tested by using micropipets to create different ratios of product and media, and were then put into breast cancer and colon cancer cells. After interpreting this data it was discovered that all of the compounds did accelerate cancer growth compared to the control, although some of the compounds had an optical density below one. The colon cancer did seem to work better than the breast cancer, and while this particular project was not successful it paved a pathway on what to research in the future.

## *Development of Nile Blue A Liquid Crystals as Potential Sensors for Date Rape Drugs*

### **Everett Case**

Berrien County Math & Science Center

A study in chemistry to understand the sensing capabilities of Nile Blue A in relation to GHB and Ketamine. Includes the synthesis of long chain carbamates, synthesis of long chain esters, and the diazotization of the long chain molecules. Three dyes with varying chain length were created and set to be tested with analogs of the secondary amine in Ketamine and the primary acid in GHB.

## *Synthesis and Antifungal Activity of Biodegradable Quaternary Ammonium Acylals.*

### **Robert Clark**

Berrien County Math & Science Center

Hybrid drugs are at the forefront of developments in the pharmaceutical industry, and they are efficient at fighting against drug resistant microbes. This research is intended to result in the synthesis of a novel biodegradable quaternary ammonium acylal (QAA), a hybrid drug for antifungal purposes. 15 unique products were created from a two-step one-flask process utilizing different reagents: one aldehyde, one tertiary amine, and an acid chloride. The 15 products were then tested for their ability to inhibit fungal growth against *Saccharomyces cerevisiae*. Results show that aldehyde length affects the viscosity of the QAA, and some novel aldehydes do not result in QAA synthesis. Zinc oxide is an efficient catalyst, and longer reflux times ensure a complete reaction. Ultimately, no products are superior as antifungals, but the products synthesized using triethylamine and benzaldehydes perform the best. Some products have shown promise as insecticides, however. If QAAs function as insecticides but not antifungals, there is strong potential for them as a commercial product if biodegradability is ensured through additional experiments.

## *Azo-Indophenol Sensors for Vitamin C*

### **Matthew Davis**

Berrien County Math & Science Center

In this experiment, we synthesized and developed a plurality of chemical sensors for Vitamin C by modifying an existing sensor, Dichlorophenolindophenol, by attaching an azo-amine to the structure. By creating this new sensor, we are hoping that we will get new colors of sensors.

## *Testing of Chemical Compounds as Potential Pesticides*

### **Logan Edwards**

Berrien County Math & Science Center

This project was to see how well and how fast different chemical compounds killed the common fruit fly, or *Drosophila melanogaster*. The results turned out to be very good. In a 30 minute times period, the majority of the flies were killed in each experimental tube. In the 5 hour time period, all the flies in the experimental tubes were dead. With the small data that was collected, we know that the compounds that were used were successful. However, the "best", or fastest one was the compound RC8B due to it having the highest ratio of dead flies to total flies at the 30 minute mark.

## *Synthesis and Sensing Properties of Azooximes*

**Collin Esarey**

Berrien County Math & Science Center

Organophosphates, many of which, like Sarin gas, are colorless and odorless. This makes it very difficult to detect these chemicals and easy to become susceptible to their side effects. Organophosphates deactivate the enzyme Acetylcholinesterase in the nervous system that breaks down Acetylcholine that carries signals between nerves and muscles. The nerves then become overactive and can be dangerous to humans and other invertebrates.

One solution to the problem is through the Synthesis of Azooximes in a manner to use the compound as a chemical sensor to detect Organophosphates. An Azooxime is made up of two main functional group components: an azo functional group and an oxime functional group. This project is unique in the sense that it has the azo directly bonded to the oxime in hopes of optimizing the sensing capabilities of the two working together.

## *Programming Madness and the title of the paper was Using Statistical Modeling to Predict the Outcomes of March Madness*

**Micah Gamble**

Berrien County Math & Science Center

This project examined the possibility of designing a program that could predict accurately the outcomes of March Madness based on statistical modeling. To test the possibility, a program was written. This program utilized many if/else statements comparing stats and a variety of random numbers. The reliability of the program was calculated to be 66.77% per game or a one in 8.88 trillion chance of a perfect bracket. This result was much less than the goal of one in 200 million, but the program did beat the average person and the average "expert" by 10% and 6% respectively.

## *Synthesis and Biological Activity of Novel Formazan Tetrazoliums*

**Matthew Gremaux**

Berrien County Math & Science Center

The purpose of this experiment is to create a cell metabolism assay using tetrazolium salts. The salts will reduce into brightly colored Formazan dyes when exposed to the active mitochondria in living cells. This color change is a result of the disruption of the tetrazole ring in the salts. This ring is the core of the salt and contains four nitrogens. While there are different assays in use today, the one made in this experiment is the MTT assay. This means one of the four nitrogens in the tetrazole ring is positively charged and allows it to easily access eukaryotic cells. The reason why these are being made is to track the progression of diseases in cells. By detecting the presence or absence of metabolic processes in cells, the cells can be classified as either living or dead and the disease can be tracked.

## *Synthesis and Biological Applications of Liquid Crystalline Nile Blue A Amides*

**Jared Hainey**

Berrien County Math & Science Center

Nile Blue A is a biological dye that has many applications for staining different things. By turning it into a liquid crystal, I hope to find different applications for it. In my experiments, I varied the chain length of the acid chloride that I reacted with Nile Blue A. Each liquid crystal was a different color ranging from light blue to dark green. When finding an application for the liquid crystals, I tried many things, the experiments that had the most success were when I ran a gel with DNA and stained the DNA through the gel. The process, however, was too long and was not a viable alternative to the commercial DNA staining dyes. Other applications for the liquid crystals may lie on different attributes like being thermotropic.

## *Synthesis and Sensor Applications of Liquid Crystalline Dichlorofluorescein Esters*

**Matthew Harazin**

Berrien County Math & Science Center

Dichlorofluorescein is a biological stain commonly used for detecting intracellular hydrogen peroxide. Reacting the compound and turning it into a liquid crystal gives it additional properties and could potentially be used in a variety of ways and applications. By refluxing the dichlorofluorescein with a variety of alkyl halides and boronic acids, the liquid crystalline dichlorofluorescein esters were synthesized. These products were tested as sensors for hexylamine, diethylamine, triethylamine, a variety of thiols, hydrogen peroxide, Vitamin C, and sodium azide. There were testing with three different solvents, acetonitrile, DMSO, and methanol. The testing with the acetonitrile offered little variance between the products but the testing with DMSO and methanol produced better results.

## *Synthesis and Anticancer Activity of Fatty Acylureas*

**Samantha Hildebrand**

Berrien County Math & Science Center

My project is about the synthesis and anticancer activity of fatty acylureas. The goal of my project is to create a chemical that slows the spread and growth rate of various cancer cells. I wanted to do this project about anticancer activity and hybrid drugs because I have had many people in my family battle and die due to cancer. I would love to take part in the research of cancer and the drugs that are being used to battle it because has affected my life in such a personal way. These experiments will be finding the reaction that leads to the greatest yield and is also effective. This will be done by changing catalysts, solvents, and the organic starting materials. The length of time that the experiment is refluxing will also be changed to allow more reaction time. Once enough experiments have successfully worked, I will be transferring over to biology where I will be applying the product to the cancer cells. After testing, the three compounds that I used on the cells proved show positive results in slowing the growth rate of the cancer cells.

## *The Synthesis and Anti-Cancer Activity of Heterocyclic Boronic Acid Substituted $\alpha$ -Cyanostilbenes*

**Elizabeth Hartz**

Berrien County Math & Science Center

This project involves creating hybrid drugs, called  $\alpha$ -cyanostilbenes, and determining if they are able to shrink cancerous cells. I spent one semester in chemistry creating the drugs, or products, and I spent the other semester in biology, to determine if they would actually be able to shrink cancer cells. In chemistry, I combined boronic acids, which are known to have biological properties, and acetonitriles, to create the  $\alpha$ -cyanostilbenes. In biology, I took these products, and mixed 20 mg of each into one ml of dimethyl sulfoxide (DMSO). After dissolving the  $\alpha$ -cyanostilbenes, I combined the solution with media (cell food) and then inserted the mixture into the cancer cells to see if the cells would shrink.

## *Synthesis and Sensor Application of Liquid Crystalline Eosin Y Esters*

**Marcus Hurt**

Berrien County Math & Science Center

This project combines Eosin Y with a secondary reactant to create a product that will react to ammonia and amines. The solvent used was acetonitrile. It was hypothesized that the products of this reaction would change in color or fluorescence when exposed to different amines. The product created was fluorescent and the IR and NMR spectra achieved the desired outcomes. However, when the product was mixed with the chosen amines (Hexyl Amine, Diethylamine, and Triethylamine) the reactions were physically undifferentiable. The reactions of the products were done in acetonitrile and it is proposed that future work could be conducted using DMSO as a solvent.

## *Effect of Boronic Acid Appendages on Chitosan Hemagglutination Properties*

**Alec Janowski**

Berrien County Math & Science Center

The purpose of this project is to append boronic acid to a chitosan polymer. We hope to observe enhanced blood agglutination properties of the chitosan after the boronic acid is attached. We predict that the conjugate will bind to surface carbohydrates on blood cells, and we hope to identify blood types based on chain shape. We will also observe any blood clotting properties of the product.

## *Synthesis and Anticancer Activity of Quinoline $\alpha$ -Cyanostilbenes*

**Cecily Kaufmann**

Berrien County Math & Science Center

The purpose of this interdisciplinary research project is to synthesize different quinolines and  $\alpha$ -cyanostilbenes and test their anticancer activity on the various cancer cells we have (breast cancer, glioblastoma, and colon cancer) in the lab. In forming a hybrid drug, I hope to add to their individual properties and observe what they accomplish when bonded together rather. Through an organized reaction, I will be creating a new compound from quinolines and  $\alpha$ -cyanostilbenes, and then I will be testing my product for any anticancer activity.

Quinoline is a nitrogen containing aromatic compound that has a molecular formula of C<sub>9</sub>H<sub>7</sub>N. Quinoline has shown antimalarial, antibacterial, antifungal, anthelmintic, cardiotoxic, anticonvulsant, anti-inflammatory, and analgesic activity. Stilbenes are natural phenolic compounds that function as antimicrobial phytoalexins in plants. They are known from other research to affect the human health as a cardioprotective, as well as antibacterial, antioxidative and anti neoplastic agents. Additionally, evidence of antifungal, estrogenic, antitumoral and tyrosinase inhibitory activity has also been observed. Stilbenes are produced by plant organisms in a defensive response to an infection after exposure to microorganisms. I am very interested in their potential health benefits and capacity to improve the disease resistance in human cells based on the above properties gathered from previous scientific studies.

I decided to pursue this project because I went to Togo over the summer and I held a tumor in my hand. I helped surgically remove and cut open a tumor from inside a woman's body. The way it had misshapen her organ and caused her pain really made me realize how big of a problem cancer is. I felt that the cancer research field was even more important than before.

## *The Music of Chaos*

**Noah Khanfar**

Otsego High School

The aim of this study is to better understand the origins of underlying patterns that exist in chaotic systems. Even simple deterministic systems can exhibit complex behavior that appears to be random. One characteristic of chaotic systems is extreme sensitivity to initial conditions. Ongoing research is exploring the effects of chaotic dynamics in physical systems (e.g. the weather). We have studied the electronic realization of a system of differential equations that exhibit chaos known as the Lorenz system. This included simulating and constructing the circuit on a breadboard. The circuit behavior qualitatively matched simulation results. The circuit allowed us to observe complex patterns, or, more specifically, how trajectories of the system states change over time without repeating even though the states are confined to a specific region. This provides a visual perspective on the phenomenon of chaos as provided by the Lorenz attractor. We also plan to use the resulting waveforms as an audio source to listen to these patterns.

## *Air Resistance is a Drag*

**Aidan McKiernan**

Berrien County Math & Science Center

This project was to see how well and how fast different chemical compounds killed the common fruit fly, or *Drosophila melanogaster*. The results turned out to be very good. In a 30 minute times period, the majority of the flies were killed in each experimental tube. In the 5 hour time period, all the flies in the experimental tubes were dead. With the small data that was collected, we know that the compounds that were used were successful. However, the “best”, or fastest one was the compound RC8B due to it having the highest ratio of dead flies to total flies at the 30 minute mark.

## *Synthesis and Biological Applications of Liquid Crystalline Azure A Amides*

**Conor McKiernan**

Berrien County Math & Science Center

Synthesis and Biological Applications of Liquid Crystalline Azure A Amides is meant to make the biological stain Azure A into a liquid crystal and then find a biological application for the chemical. To make it a liquid crystal, an amide group with a long carbon chain is attached to the Azure A molecule. This is all done in the lab with the dye, an acyl chloride, a catalyst, and a solvent. Once a liquid crystal version of Azure A is found, a biological application will be investigated. (When we get to the biology part I will add the application which could likely be thermochromism or photochromism).

In this project, the production of liquid crystal biological stains was explored. The liquid crystals have potential applications in biology. The effectiveness of the production procedures is analyzed through IR and NMR scans.

## *Synthesis and Antiparasitic Properties of Rare Benzooxahaheptalactones*

**Erica Mitchell**

Berrien County Math & Science Center

In this experiment I tested different forms of zinc and aldehydes with phenyl chloroformate to find a compound successful in killing fruit flies and that could potentially be used in agricultural as a pesticide. I spent most of my year working in chemistry with different reactions trying to find the best one. I found that the Zinc acetate with valeraldehyde had the best reaction and so from there I began testing with different aldehydes. After collecting some successful products I put my products into 3 ml of 100% DMSO. This solution was then absorbed into a paper at two different strengths, full strength and half strength. The two different strengths were then placed in with fruit files overnight and were judged on effectiveness the next day according to whether the flies were alive or dead.

## *Development of Colorimetric Sensing Method for Vitamin C*

**Kaylee Moore**

Berrien County Math & Science Center

The purpose of this research project is to create a colorimetric sensor method for Vitamin C by means of diazonium salt with varying amines. Diazonium salts are important intermediates in the organic synthesis of azo dyes. Diazonium salts contain a R group with which can be interchanged to create different compounds. Diazonium salts obtained by creating azo compounds are useful in dyes. The deep colors the azo dyes produce reflect the desired component. By varying the chemical structures of the amines that are diazotized and colors vary throughout the visible spectrum. Research into the benefits of proper amounts of Vitamin C have shown that the substance produces great health benefits to the human body. Vitamin C produces collagen which is an important component to the functioning of certain neurotransmitters and the immune system. Vitamin C also shoes to have a important role in the repairing of tissues, bones, blood vessels, and

the skin. Diazonium salts have shown have also exhibited results that would help produce a colorimetric sensing method for Vitamin C. Many variations of the aromatic amines have shown to highlight the amount of Vitamin C presented. Colorimetric sensors are prepared, as shown in the procedure, by reacting a solvent containing Vitamin C, with a compound of diazonium salt. These reactions vary in color and intensity. Twenty five different aromatic amines were combined with the Vitamin C solvent to create twenty five different diazonium compounds. These then were testing through IR and NMR to identify the components structure. The results showed that the reaction could be the following structure.

### *Synthesis and applications of Sudan II Carbamates*

**Matthew Norris**

Berrien County Math & Science Center

The research project discussed in this poster is the synthesis and applications of Sudan II carbamates and esters in liquid crystalline form. Liquid crystals are a state of matter in between liquids and solids. Liquid crystals are implemented into almost everyone's life on a daily basis. Liquid Crystals are the main component of liquid crystal displays, or LCD. My research consisted of transforming Sudan II into a liquid crystalline state, and then testing the products with various solvents. While my research was somewhat inconclusive, there are many applications these Sudan II liquid crystalline products could be used for.

### *Development of Novel Acyclic Tris-Quat and Quat-Quat Transfecting Agents*

**Jasmine Sindelar**

Berrien County Math & Science Center

Transfection is the process of deliberately introducing nucleic acids (specifically DNA) across plasma membranes from one cell's nucleus into another cell's nucleus. Transfection can be used for gene editing, therapy, and cloning. Recently, transfection has been used in the treatment of viruses and mycobacteria. The purpose of this project is to find a cheaper and more effective means for transfection to occur. The process includes synthesizing pentamethyldiethylenetriamine or hexamethyltetraamine with a halide to create, respectively, a tris-quaternary or quat-quaternary transfecting agent. Some of these products were diluted and combined with a Monster Green plasmid DNA and placed in wells containing cancer cells. If the cells glowed, then transfection was successful. Of the results obtained, the following conclusions were made: an increase in hydrophobicity of the halide, as well as an increase in quaternary centers, seems to decrease transfection efficiency. In the future, it would be beneficial to test the products containing boronic acid substituted benzyl halides.

### *Synthesis and Biological Applications of Liquid Crystalline Martius Yellow*

**Kailey Skarbek**

Berrien County Math & Science Center

The purpose of Synthesis and Biological Applications of Liquid Crystalline Martius Yellow Carbamates is to see what Martius Yellow added with a isocyanate or organic halide can stain. Butyl isocyanate, octyl isocyanate, dodecyl isocyanate, octadecyl isocyanate, bromohexadecane, bromododecane, bromooctane, and bromohexabe were all added with Martius Yellow to make a product. Once the products were made, they were used to dye different objects like hair, blood, and eggs. Each stain was compared with the control stain, Martius Yellow.

## *Development of Novel Acyclic Bis-Quat Transfecting Agents*

**Luke Smous**

Berrien County Math & Science Center

The main purpose of this project is to see if there is a better way to transfect DNA from one nucleus of a cell to another. In order to test this, I chose to study the development of novel acyclic Bis-Quat Transfecting Agents. To do this, I had to set up experiments to determine if these transfecting agents work. Chemically, I had to reflux reagents, filtrate it, and then isolate it to collect the final product. Then with this final product, I was able to test if it could transfer DNA from one cell to another. The main goal of this research project is to see if our final products could transfect DNA better than commercial products. In the end, I found that my Perfluoro Iododecane product and my 1-Bromohexadecane product both proved to be better transfecting agents than the control product (Fugene).

## *Synthesis and Anticancer Activity of Arylidene Pyrazolones*

**Brandon Strickland**

Berrien County Math & Science Center

The goal of this research is to synthesis and then to test arylidene pyrazalones in cancer cells. This is significant because this research will either point in the direction of the cure to cancer or will disprove a possible cure. By stirring together four chemicals and then vacuum filtering the excess water out I was able to create eleven compounds I could potentially test. The three that reacted best determined by taking the IR and NMR, were tested. Compounds created from experiments one, two, and ten were used. I then created four ratios of compound, DMSO, and media to test for each compound. After putting 100 microliters of each of the four ratios in to three separate wells and dying them later, I used a spectrophotometer to test the effectiveness of each compound. Compounds one and two failed in most tests by increasing the growth speed of the cancer. Product 10 however was successful and slowed the cancer in each of its trials compared to the control.

## *Heterocyclic Arylidene Chemical Compounds vs. Glioblastoma*

**Megan Wieger**

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Glioblastoma multiforme (GBM) is a very deadly form of brain cancer. The effects of hybrid compounds of heterocyclic rhodanine and arylidene (boronic acid) were tested on GBM cancer cells. The cells were grown in 96 well culture plates and treated with four different concentrations. Since both drugs had anti-cancer properties, the hybrid had a high probability of killing a large amount of cells. The goal was to kill as many cells as possible with the lowest concentration possible. The compound of rhodanine-4-formyl-phenyl boronic acid (J MCL 1) showed a large decrease in the total cell count, while rhodanine-paraformaldehyde (J MCL 4) had significant decrease with the 2.0 mg/mL concentration. The results proved that the highest concentration was most effective. It was concluded that bonds in para-position on the benzene ring cause a significant effect on cell count.

## *Synthesis and Antibacterial Activity of Phenolic Azo Drugs*

**Brianna Wright**

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The Synthesis and Antibacterial Activity of Phenolic Azo Drugs was conducted in the hybrid drug research category. The objective of the research conducted on this subject was to find a way to combine phenol and azo dyes in order to be used in bacterial elimination. The reactants used with the phenols were eugenol and thymol. Eugenol was tested first, and when the amount of product formulated was minimal, thymol was tested with much more successful results. Attempted to use in the azo dye was sulfanilamide, 4-Aminophenylboronic Acid-HCL, 4-Aminobenzoic Acid, 4-Aminosalicylic Acid, and 2-Aminothiazole as the reactants. Sulfanilamide was tested with both eugenol and thymol. 4-Aminophenylboronic Acid-HCL, 4-Aminobenzoic Acid, 4-Aminosalicylic Acid, and 2-Aminothiazole were each tested with only thymol. These were unable to be tested in biology, so in the future testing the products in biological reactions will be able to reveal the most effective reactant.