Abstracts for the 31st Annual Loudoun County Regional Science & Engineering Fair

March 15, 2012
Woodgrove High School

Sponsored by Orbital Sciences Corporation
Loudoun RSEF Categories
100 Animal Sciences
200 Behavioral & Social Sciences
300 Biochemistry
400 Cellular & Molecular Biology
500 Chemistry
600 Computer Science
700 Earth & Planetary Science
800 Engineering: Electrical & Mechanical
900 Engineering: Materials & Bioengineering
1000 Energy & Transportation
1100 Environmental Management
1200 Environmental Sciences
1300 Mathematical Sciences
1400 Medicine & Health Sciences
1500 Microbiology
1600 Physics & Astronomy
1700 Plant Sciences

For detailed category descriptions visit the ISEF website at:
http://www.societyforscience.org/isef/project_categories

Project Numbering
For exhibition, all projects are given a number. The first series of numbers indicates the category & project number. The letter represents the school. The last numbers indicate the student’s grade.
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The Effect of Ethanol Ingestion On Obstacle Avoidance Ability of C. elegans

Victoria Burnum
Stone Bridge High School (SBH)

Alcohol blocks neuro-receptors which affects emotional and sensory function, perception, judgment, memory, learning ability and impairs motor coordination, reaction time and physical response.

Caenorhabditis elegans is used for behavioral assays in neurobiological/behavioral studies for assessing contribution of genes towards phenotype (neurons) that is specific behavior, and metabolism of biologically significant compounds (alcohol) in humans and its physiological effects on nervous system.

The experiment tests effect of ingestion of 200mM (120µL 95% ethanol), 400mM (234µL 95% ethanol) (IV) on obstacle avoidance ability (DV) of C. elegans strains, N2 (wild type) and glr-1(n2461) by comparing percentage nose touch responses. The percentage was calculated by counting the number of times worm hit the eyelash placed perpendicular in path and backed up (positive response) or went over/under/around or stopped (no response).

T-test showed statistically significant difference p<0.05 in obstacle avoidance ability of N2 and glr-1 without ethanol (glr-1 defective n2461 gene glutamate receptor required for nose-touch aversion), N2 no ethanol and 400mM, and glr-1 no ethanol and 200mM. T-test did not show significant difference p>0.05 in ability of N2 and glr-1 200mM ethanol, N2 and glr-1 400mM, N2 no ethanol and 200mM, and glr-1 no ethanol and 400mM.

Both ANOVA (N2 no ethanol, 200mM, 400mM) and (glr-1 no ethanol, 200mM, 400mM) returned p<0.05. N2 obstacle avoidance ability declined from 82% (no ethanol) to 78% (200mM) to 60% (400mM), supporting the original hypothesis. The glr-1’s obstacle avoidance ability increased with 200mM, then declined at 400mM.

Further research would test N2 again to confirm the accuracy of assay. C. elegans’ attraction towards or avoidance of other biologically active compounds can be studied in future to find a preference of mutant strain.

I/We hereby certify that the above statements are correct and the information provided in the Abstract is the result of one year's research. I/We also attest that the above properly reflects my/our own work (digitally signed).
The Effect of Dish Soap and Vegetable Oil on Stink Bug Populations

Van Do
Park View High School (PVH)

In the fall time of the year, stink bugs tried to find a warmer habitat to live, and they chose human houses. Stink bugs create a very strong odor, and tend to destroy household items, food and, crops. The purpose of this experiment is to test normal household detergents on stink bugs and prevent them from destroying human property. The independent variable is the different dish soap and vegetable oil mixtures. The dependent variable is the amount of stink bugs that die. The control was the Dish soap and Canola oil combination. Experiment was using Chi-test. In the experiment, dish soap was mixed with vegetable oil, and sprayed on the stink bugs. It was recorded how many stink bugs died in 90 minutes. The alternative hypothesis was Dish soap and Canola oil will effect the stink bug populations more than other dish soaps and vegetable oils (Ajax soap and Kujawski oil, Palmolive soap and Valrico oil) combinations, and it was not supported. The independent variables did not effect the dependent variables. The means of three combinations result was 1.6. The statistics showed the p value is 0.66 meaning p > 0.0001. Different dish soaps and vegetable oils did not give a different affect when applied to the stink bugs. Further research could explore a stronger ammonia base would effect the stink bugs more than the dish soaps and vegetable oils.

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The Effect of Decreasing Daphnia’s Heart Rate with Natural Remedies after Exposure to Adrenaline

Alyssa Meyer
Tuscarora High School (THS)

Testing human heart rate is difficult but also very important. By being able to test a Daphnia ambigua (Daphnia), doctors will be able to see what different kind of natural remedies will have an effect on the human heart. The data collected was based off increasing the Daphnia ambigua’s with adrenaline and then decreasing the heart rate with alcohol, acetylcholine, and cold water. For each of the natural remedies fifteen trials were completed, using one Daphnia ambigua per trial. Each of the natural remedies was given at different amounts because some were more effective and would kill off the Daphnia ambigua. Alcohol decreased the heart rate the quickest and only needed an extremely small amount compared to the effects of acetylcholine and cold water. However because the amounts were so different it makes it harder to be able to compare them, but data shows that there is a significant different between the cold water vs. alcohol, the acetylcholine vs. cold water and also the alcohol vs. acetylcholine. All of them rejected the null hypothesis by being lower than .05 from the original.

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The Domestication of Animals Using Nurture and Selective Breeding

Christina Nelson
Loudoun Valley High School (LVH)

The purpose of this experiment was to track how animals have been domesticated. By collecting data from silver foxes, the physical and genetic changes that follow domestication were discovered within just a few generations. This could be done on another animal, in a shorter amount of time than the wolf and caribou, using the guidelines from the fox experiment. After collecting information from domesticated animals including the dog, reindeer and domestic fox and comparing the good/bad qualities of its wild relatives, qualities kept and taken away during domestication and the resulting qualities of the domesticated form. Using a list of factors to determine optimal domestication, an animal was selected. The independent variable is the changing genetics through selective breeding. Dependant variable: temperament, physical structure, and color. Based off this information the moose met most of Diamond's requirements and showed promise for domestication. Using information from qualities of domesticated animals, the qualities of a possible future domesticated moose were predicted. The null hypothesis, that moose are too dangerous and wild to be domesticated, was rejected, because they become more predictable and tame when raised from birth. If moose were domesticated, according to other domesticated animals, the process could be accelerated using the discovery by Belyaev. Physical structure and genetics would change if selectively bred for good temperament. Further research: domesticating the moose. This would require many moose, years, financial resources, and dedication to the strict selective breeding process.

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The Determination of the Possible Presence of Beta-methylamino-L-alanine (BMAA) in Feline Food

Gerald Pydeski
Dominion High School (DMH)

Beta-methylamino-L-alanine (BMAA) is an amino acid believed to be a neurotoxin. First discovered on Guam during World War II, this chemical is believed to cause Parkinson-like symptoms in natives. The origin of BMAA is a staple of native diet, flying foxes who consumed BMAA-containing cycad seeds. Beta-methylamino-L-alanine accumulated in the cycad seeds via intake by nitrogen-fixing cyanobacteria associated with the cycad roots.

The purpose of this research was to determine the possibility of the presence of BMAA in Felis catus (domesticated house cat) food. The thought is that salmon meal in the cat food would contain BMAA because salmon ingest organisms that feed on algae containing BMAA. Three kinds of cat food with salmon meal were ground, sterilized and diluted in distilled water. Filter paper was dipped into this cat food mixture and was then placed on Petri dishes cultured with E. coli. Trials consisted of five test plates as well as five plates subjected to BMAA-hydrochloride. The samples were incubated and zones of inhibition were measured.

It was determined there was a significant detrimental effect on the growth of cells. Since sterilization of the cat food removed the possibility of any damage caused from an outside source such as fungi, it is supposed that BMAA may be present in salmon meal in the cat food. Further research would include LC/MS analysis of the cat food to determine BMAA’s presence. Ultimately the hope is to determine its existence in pet food to prevent feline neurological disease.

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Are Horses (Equus caballus) Capable of Associative Auditory Learning?

Alexandra Sarkis
Dominion High School (DMH)

The purpose of this experiment was to determine whether horses are capable of auditory learning by associating specific sounds with specific choices. The independent variable was the different sounds presented to the horses. The dependent variable was the horse’s ability to correctly match the sound to the corresponding bucket. Results were recorded for each trial. The control was a horse that did not participate in the training. Over the course of 10 weeks, the experiment rotated between training and testing phases. During the 9 testing phases, results were recorded as to the number of times the horses made the correct selections. The results showed that Jazz had the highest percentage of correct answers with 97%, followed by Jenny (94%), Carpet (93%), Billy (90%) and Lacy (84%). The control horse, Turtle, had 50% correct. This data was statistically significant because the p value calculated was less than .05. The hypothesis was that horses could be trained to associate different sounds to different selections. The results showed that this was the case and that although the whistle was the most effective training sound, all of the sounds could be used. The experiment could be improved by ensuring more standardization in the testing schedule and eliminating outside distractions. The experiment could be expanded to include a wider variety of sounds or objects to determine whether certain sounds or objects are more easily differentiated or to introduce more complicated tasks to determine whether horses could be queued to undertake more complex actions.

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The Effect of an Experimental Anti-Aging Drug on the Lifespans and Behavior on the Common Cricket, G. Assimilis.

Melissa Skirkanich
Tuscarora High School (THS)

Aging is one of the many problems that we have in which we have no cure. Diseases and the aging process are linked to the cells in the body wearing down over time. If we could stop those cells from wearing down, we could improve the quality of life, which is the purpose of my experiment. The independent variable was the amount of Mannheptulose given to the crickets, and the dependent variable was the activity rating of those crickets. The control group was 25 crickets who received no Mannheptulose. Every few days, each cricket was observed for one minute based on their activity level. I conducted a Pearson R correlation for my data. For day 1, the result was -0.96. For day 2, the result was -0.87. For day 3, the result was -0.89. For day 4 the result was -0.78. And for day 5, the result was -0.55. The closer the number is to either +1 or -1, the stronger the correlation. Since the correlation is negative, the two variables have a negative relationship, meaning that as one increases, the other decreases. I rejected my null hypothesis. This could mean that Mannheptulose should be farther investigated as an anti-aging medication. For future research, there needs to be a more efficient way to extract the crickets in the least amount of time possible. Also, there shouldn’t be so many crickets in one living space and scientists should explore lifespan, as well as activity rating.

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The Effect of Offshore Wind farms on Sand Eel Populations

Zoe Textoris
Heritage High School (HTH)

The purpose of this experiment was to determine whether or not the presence of wind farms had an effect on sand eel populations. This is important because the sand eel is a vital part of the Northern-Atlantic food chain. The independent variable of this project was the presence of wind farms. The dependent variable was the population size of Sand Eels at Horns Reef. The results will be measured in the number of Sand Eels. The population size will be measured by the amount of sand eels caught at certain times. In this experiment all results will be compared to the environment and sand eel density prior to the wind farm at Horns Reef. The results that will be compared will be the population size of the sand eels. The procedure used will be to research data and then use a t-table to compare it. The mean of the control group was 9.42 Sand Eels. The mean of the experimental group was 24.37 sand eels. The alternative hypothesis was that if a wind farm is built in an area with a sand eel population, then the sand eel population will increase. In the experiment the alternative hypothesis was supported. The independent variable did affect the dependent variable. Further research could explore the reason that the wind farms had an effect on the sand eel population.

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The Effect of Chemicals on the Heart Rate of Daphnia magna

Emma Toomer
Loudoun County High School (LCH)

Chemicals poured into drains and in run-off from urban areas can have a considerable effect on food sources for fish in streams and bays as well as affecting the fish themselves. This experiment investigated the effects of two toxins, methanol and caffeine, to test their effects on the daphnia magna’s physiology. Observing the effects of the chemical on daphnia heart rate gave a good indication of the stress toxins have on the animal and demonstrated that pollutants can have a dramatic effect on the first level of the food chain.

Forty-two trials were conducted on separate daphnia using varying concentrations of two chemicals. Each daphnia was introduced to the solution for two minutes, after which the heart rate was counted for ten seconds. The number of beats in ten seconds was multiplied by six to achieve beats per minute. In the case of the caffeine, the heart rate increased significantly. Methanol results were more inconclusive. Caffeine had a substantial effect on daphnia hart rate. The methanol had the opposite result. All statistics were found using a paired t test. For the caffeine the null hypothesis was rejected, whereas for methanol it was accepted, thus proving the methanol results were inconclusive. Original assumptions stated that both methanol and caffeine would have dramatic affects on the daphnia heart rate. These assumptions are false as only the caffeine had any real effect.

Further research could be done to explain the lack of effect from the methanol.

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The Effect of Temperature on the Rate of Decomposition of Pig Liver by Sarcophaga bullata Larvae

Madeline Warndorf
Woodgrove High School (WHS)

The effects of temperature on the rate of decomposition of pig organ flesh by Sarcophaga bullata larvae; was observed in this experimentation. This experiments purpose is to show how different temperatures affect the decomposition of a human body with the presence of flesh eating insects; showing this, it will help being able to date the person’s time of death. The temperature [2°C, 22°C, and 37°C] was the independent variable. The mass of the pig liver, showing decomposition, was the dependant variable. The control group in this experiment was Day 0 for each temperature. This is where the exact same mass [10 g] for each piece of liver and exact same mass for every 20 Sarcophaga bullata larvae per jar. The 45 jars divided into the three temperatures above, with the 10 grams of pig liver and the 20 larvae were observed for 8 consecutive days. The mean of the mass of pig liver over the course of the 8 days was 9.73583 g for 2°C, 7.3937 g for 22°C, and 6.06333 g for 37°C. Comparing this to the control of 10 g for each temperature, proved the hypothesis, if the temperature is hotter, then the Sarcophaga bullata larvae will be more active and decompose the liver at a faster rate. The independent variable had an effect on the dependant variable because of how the larvae grow and consume. Sources of error could include dehydration of the liver. Further research could explore how temperature effects the life cycle of Sarcophaga bullata.

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<td>Villalobos, Sarah</td>
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<td>Vu, Catherine</td>
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<td>219V10</td>
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<td>220F10</td>
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<td>The Effect of Video-Games on Spatial Orientation.</td>
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The Effect of Age on Perception of Personalities

Boluwatife Adetunji

Tuscarora High School (THS)

My project is the effect of ages on personalities and their popularity. This will help because finding out if personality and popularity are directly related and if they change with age. This might help us boost confidence. Do perceptions of popularity change with age? My hypothesis is that age does not effect the perception. My IV is ages of the participants taking the survey, and my DV is the perception of which personalities is most popularity. Approximately 50 students and 50 adults participated in which they ranked all the personalities into their top 5. The results showed that all the Introvert personalities where ranked significantly lower than the Extravert in both adults and students. Therefore my hypothesis was accepted.

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The Effect of Music on Spatial Reasoning Ability

Devon Bates
Briar Woods High School (BWH)

Every teenager says that music helps their studying, but does it really? The purpose of this experiment was to show whether or not certain genres of music affected the outcome of spatial reasoning ability. Listening to techno, classical, and pop music was compared against listening to silence, and the test scores. Subjects were high school students, aged 14-18. Students took the test, listened to 10 minutes of music, and then took the test again. Incorrect answers after the test and second test were as follows, respectively: Techno 36% to 22%, classical 23% to 23%, pop 36% to 30%. The T-test probability was 2.447 for all the independent variables. The outcome for techno music was 0.2533, classical was 0.8307, and pop was 1.6207. The null hypothesis, that music does not have an effect on spatial reasoning ability, was rejected in all 3 experimental groups. Sources of error could have included distractions from the music or from the test itself, or mis-recording the outcomes. Further research could include using different age groups, or expanding the spectrum of music used.

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The Effect of Religious Views on Political Views

Madeleine Doherty
Woodgrove High School (WHS)

This experiment's purpose was to find a correlation between one's religious and political views, revealing what impact religion could have on political opinions. The hypothesis of this experiment stated that if someone's life is strongly impacted by their religious views, then their score on a political opinion survey will indicate that they have more conservative political views. The findings of this experiment refuted the hypothesis.

30 human test subjects, over the age of 18 were used in this experiment. They participated by completing a political ideology survey in which they rated their level of agreement with a series of political statements; it also asked about the intensity of their religious views. This experiment had no control. The assessments of the test subjects’ religious views served as the experiment's Independent Variable; their scores on the political ideology surveys served as the Dependent Variable.

Those whose religious views moderately impacted their daily lives had the highest mean, a score of 123.25, and the lowest standard deviation, of 9.58794. The middle-scoring group of test subjects was made up of those characterized as having their daily lives strongly impacted by their religious views, with a mean score of 122.27; their standard deviation was 17.51778. Those whose daily lives were not impacted by their religious views had the lowest central tendency, with a mean score of 119.45. The group also had the highest standard deviation, of 28.05384.

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How One’s Implicit Memory Bias Affects One’s Choices Towards STEM Careers

Amanda Dukinfield
Woodgrove High School (WHS)

Unconscious bias in people can be measured for almost anything. In this experiment, the bias toward science, technology, engineering, and math, or STEM, was measured. The basis for measuring STEM was to test if a positive or negative bias had any correlation toward that person’s choice toward a STEM career. A total of 148 people over the age of 21 were asked to take an implicit association test online. This test uses a series of pictures and words, which the participants would then have to identify given the choices, combined with the time the subjects take to identify the picture or word, to come up with the final bias score, or D score. That D score was then compared to the college degrees of the subject, which they listed before the test. The subjects who were involved in STEM topics had a higher average of D scores. A high score means a positive implicit bias toward STEM. The subjects not involved with STEM topics had a lower average D score than those in STEM by 0.223 of a D score. This experiment was able to prove with a 98.868% accuracy that, in fact, there is a positive correlation between one’s implicit memory bias and one’s choices toward STEM careers, which supports the hypothesis. This means that participants who had a positive bias for areas of interest aimed around STEM were more likely to be involved in a STEM related topics. Research of similar topics in the future could go into areas that explore the subtopics of STEM individually, instead of the entire, broad spectrum.

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The Effect of Musical Tempo on How People Feel About Themselves

Michael Erb
Woodgrove High School (WHS)

Can a person feel different simply because of music? The purpose of this experiment was to understand the correlation between tempo and emotion. The procedure was simple: have test subjects listen to music and then to fill out a questionnaire that asked the subjects before and after exposure to music, how much self-confidence the subjects had. The independent variable was the tempo of the music. The dependent variable was the change in how the test subjects felt. The control group was worked into the testing by having the test subjects give a report of the emotional state before listening to the music. The test subjects were all high school students and it was about even with regards to gender. The result was subjects that listened to the fast tempo music had an average self-confidence boost of 1.33 while those who listened to the slow tempo music only had a .267 average self-confidence increase (this being on a scale from one to ten). The results support the hypothesis that humans, by choosing specific music, can increase self-confidence. There were no major errors in the experiment and was overall a success. For further research it would be beneficial to examine more closely the emotions felt by the subjects in this experiment and to identify any other emotional changes, and the association with music.

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The Relationship Between Personality Type and Non-Verbal Communication

Alyssa Eversmeyer

Potomac Falls High School (PFH)

This project examined a possible factor of how people unconsciously communicate with non-verbal communication. It was designed to test whether or not personality type (in terms of introversion/extroversion) determined a person's ability to match pictures of non-verbal communication (gestures/body language) to emotions commonly associated with them. 100 high-school age male and female subjects were each given two quizzes to determine their level of extroversion and how accurately they could match pictures of people to emotions. The subjects' results were ordered by their personality types (the independent variable), and split into three groups (introverted, extroverted, and a middle control group) as evenly as possible. The matching quiz scores from each of the groups were then compared. The introverted group’s quiz results had a mean score of about 4.9 (out of 12), the control group’s mean was about 5.8, and the extroverted group’s mean was about 5.6. The Chi-Square Test for Independence was performed, and it resulted in a P-value of 0.9675, which meant that the two variables (personality type and quiz score) were independent of each other. It was hypothesized that extroverts would be more accurate at identifying non-verbal communication than introverts. This hypothesis was not supported by the statistical test, which indicated that the quiz scores were not dependent on the subjects’ personality types. Further research could explore how other definitions of personality type (sensing/intuition, thinking/feeling, judging/perceiving) affect communication, or how factors such as age would affect this experiment, since the subjects were limited to high-school age students.

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The Effect of Color on Memory

Alessa Fisher
Tuscarora High School (THS)

Color has been increasingly linked with memory and by knowing which colors have a more positive effect on children; those colors could be used more often to be therapeutic in a classroom setting. It could also potentially increase memory capabilities. In this experiment, a group of fourth grade children were shown five slides, each themed with a different color, and had 30 seconds to remember ten different objects in that specific color. Participants would either experience a positive or negative feeling toward the color, therefore causing them to do better or worse on the memory recall portion of the test. The fourth grade level is being tested because that is when they go through a crucial stage of cognitive development. After immediately taking down the slide, they were instructed to either write or draw what they remember. Once data was collected an ANOVA test was performed and indicated a significant difference between the percentages of objects recalled per color (p value is less than 0.05). In the future, more studies should be done that determine which colors have more of an enhancing and positive influence on multiple age groups.

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Identification of Visual Distress Signals

Reese Fulgenzi
Loudoun County High School (LCH)

The necessity of an emergency signaling device has been present for thousands of years; even today, in both rural or urban environments, an emergency situation can arise that necessitates the use of an emergency signal. Multiple readily available signal devices were tested in both urban and woodland environments. It was hypothesized that the Surefire White LED would be the most easily recognized signaling device in both environments; the statistical analysis supports this hypothesis. The devices tested were a Bic™ lighter, orange chemiluminescent light, generic flashlight, and a white Surefire™ LED. The data was collected by walking subjects along a predetermined path and recording the distance at which they correctly identified the signal. In the rural environment, the mean recognition distances for the Bic™ lighter, orange chemiluminescent light, Surefire white LED, and generic flashlight were 432.80m, 368.20m, 466.33m, and 425.00m, respectively. In the urban environment, the mean recognition distances were 0.00m, 74.00m, 264.17m, and 45.00m, respectively. The statistical analysis used for the collected data was a two-factor analysis of variance (ANOVA). The analysis confirmed that the Surefire White LED outperforms the other signaling devices in both urban and woodland environments. Additionally, the urban environment was found to be more challenging for signal identification with all tested devices than the rural environment. As a follow up to this study, the testing of additional signal devices and additional environmental factors, such as weather, is recommended.

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Multitasking Game as a Marker and Training Aid for Emergency Physician Productivity

Katherine Gorbach
Dominion High School (DMH)

In the United States, a combination of economic factors and political mandates has created an environment of ever-increasing demand for emergency medicine services. In order to meet this demand, the limited number of emergency physicians must optimize patient flow through the department in order to provide the highest quality care. Unfortunately, there are few markers to predict which emergency physicians will be the most efficient and little didactic instruction to help them improve.

This research project used a casual computer game that rewards multitasking and flow optimization as a proxy for a busy emergency department. Emergency physicians were asked to play this game for a three week period. Their productivity was measured before, during and after the testing interval, as reflected in their relative value units (RVU), hospital markers for efficiency. Analysis revealed that there is a statistically significant correlation between the physicians’ game scores and their productivity and that participating physicians showed an improvement in their efficiency in the immediate post-trial period. Further research would expand the pool of participating emergency physicians to include different practice environments and determination if the efficiency improvements have long-lasting impact.

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What Do You Think? The Effects of Biases in Writing on Readers

Maryam Hajialigol
Potomac Falls High School (PFH)

In the political and journalistic worlds, less is always more. In the minds of the readers/viewers, it may not always be so. This project aims to determine that any material written with bias will distort the readers understanding of facts. Three articles were written in different points of view (the IV), all about the same subject, and distributed to 60 adult subjects. These subjects in turn filled out five-question surveys about what they got out of the article. The DV was the answers to the questions, which were designed to produce different responses. The control group was the neutral article.

The hypothesis stated that the readers' view of the facts of the same event changed from one article version to another. The data and interpretations of the responses supported this.

The message behind this project is extraordinarily important. When information is miscommunicated, it runs the risk of the reader taking something from that information that is not necessarily true. It prevents the reader from being fully educated about the topic. The effect of this is seen in everything from presidential elections to media crises to scientific theories. If this goes unnoticed for an extensive amount of time, the result could be a culture and a society built on fabrication.

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The Effect of Subliminal Messages on the Subconscious Mind

Shaikim Holman
Park View High School (PVH)

Have you ever done something out of reaction to someone else’s movements, but you do not know why? This experiment tested the effect of subliminal messages on the subconscious mind. The hypothesis of the experiment is if a person is given subliminal messages, then more females will have a reaction versus that of a male, which was not supported by the data. The null hypothesis of the experiment is that if test subjects are given subliminal messages, then males and females will react to the same. The independent variable of the experiment is male or female. The dependent variable of the experiment is if the test subject reacts to the subliminal messages. The dependent variable could be because subliminal messages can influence another person. The control of this experiment is the group of subjects that did not get any subliminal messages. The subjects in the experiment are students, ages 14-18. The null hypothesis was rejected in males and females in scratching and yawning due to the chi-squared. The chi squared for yawning in 3.81 and the P-value was >.05. For scratching, the chi-squared was 3.5 which would make the P-value > .05. Sources of error in the experiment could be the different time of day because that could affect if a person is more reactive. Early in the morning would be a time that people would be more reactive to yawning. Future research on this could be to test different subliminal messages such as rubbing the nose or verbal messages.
Effects of Distraction on Quality of Driving/ Dangers of Distracted Driving

Samantha Iliff
Loudoun Valley High School (LVH)

The purpose of this experiment is to inform drivers of the dangers created by distracted driving. The effect of various distractions on driving quality was being tested where the distraction is the independent variable and the number of faults/completion time of one lap on a simulated driving course was the dependent variable. Ten subjects were tested including three adult male drivers, one adult female driver, five female teenagers, and one male child. Each subject practiced, then completed two laps with no distractions, two laps while eating, two laps while talking on the phone, and two laps while texting. Each subject ate a doughnut, was intensely questioned on their last summer vacation, and texted the sentence “I will not text and drive” several times, while their faults and time were recorded. The average number of faults and time for each variable was 6 faults and 64.77 seconds with no distractions, 13.3 faults and 71.40 seconds while eating, 15.45 faults and 70 seconds while talking on the cell phone, and 25.75 faults and 114.34 seconds while texting. Therefore texting was the most dangerous distraction. The ANOVA test was run and this test proved that the dependent variable was affected by the variable. The ANOVA test proves the null hypothesis incorrect because the means of the faults for the control group and the means for the groups that tested the variable were significantly different with a p-value of .0001. The ANOVA test also shows that means for the time for the control group and the means of the groups that tested the variable were statistically different with a p-value of 0. Further research should explore the effects of different types of distraction, by comparing cognitive, oratory, visual, and physical distractions.

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The Effect of Generational Differences on Communication

Jacqueline Liou
Freedom High School (FHS)

The purpose of this experiment was to discover how different generations communicate. This experiment was helpful because it showed how people communicate and adapt to new technology. The independent variable was the gender and the generations, Baby Boomers (1946-1964), X (1965-1980), and Millennial (1981-2000), of the participants. The dependent variable was how much technology was used when communicating as determined by a 15 question survey. There were 75 males and 75 females between the ages of 12 and 66 participating. From the surveys, the following trends could be observed: for all generations technology was used for personal and business. The Millennial generation showed use of the internet six or more hours per day. All generations highly preferred face-to-face communication, but texting was also high in the Millennial generations. Texting was the highest communication form with friends for the Millennials, but calling and e-mailing were the highest for the Baby Boomers and X. There were trends shown in the surveys on how each generation communicates. The experimental hypothesis was supported by the results in which the younger generation was more cellular based. Technology was more incorporated in the younger generation’s lives. Most adult participants were teachers. Further research could explore participants in different occupations and include more participants.

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Effect of Power Balance Bands on a Person’s Balance, Strength, and Flexibility

Cameron Molina
Tuscarora High School (THS)

This project tested the placebo effect of the original “Power Balance” Bracelet. This bracelet claimed to have a hologram in it that when in contact with your skin, allowed your body to interact with the natural frequencies stored within the hologram. This was tested by conducting an experiment where people would test this product along with a similar version of this product that claimed to produce the same results. To do this an experiment was constructed that tested a person’s balance, strength, and flexibility while wearing the “real” Power Balance bracelet and the “fake” Power Balance bracelet. The balance test consisted of one person holding their balance on one leg with eyes closed, strength was measured using an exercise band while holding their balance on one foot, and flexibility was measured using the “sit and reach” test. The constants in this experiment included the tests conducted, the power balance bands used, and environment where tests are being conducted. Results were analyzed using a T-Test and it was found that there is not a significant difference between the “real” and “fake” bands. (P-Value is less than .05). Therefore ask yourself, why spend $40 on a rubber band.

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A Correlation Study of Climate and Autism Clusters in the United States

April Reed
Dominion High School (DMH)

Currently, the cause of autism is the subject of wide debate. Although certain genetic disorders are known to cause autism, whether vaccines are linked to autism remains controversial. With the number of autism cases on the rise, there is increased amount of interest in determining causes.

The purpose of this research was to determine if any correlation or trend could be discovered by comparing different weather variables and prevalence of autism cases. Temperature, precipitation, and barometric pressure averages were taken for the states analyzed and were compared to the percentage of autism cases per state. It was determine that barometric pressure appeared to play little role in the number of autism cases occurring in those states analyzed. However, there appeared to be a slight positive correlation between temperature and precipitation and the occurrence of autism.

Hence number of cases of autism was slightly higher in the states having higher temperatures and increased precipitation. This may be due to the fact that children may have spent more time inside to escape these environmental conditions hence increasing their exposure to household chemicals which have been supposed to be linked with autism. Further research would entail an analysis of weather conditions and autism cases in all states to give a more complete picture of what is occurring across the nation. This is important because it could assist parents to determine healthy environments for their autistic children.

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Will a Hands Free Device Really Improve Reaction Time? Is it the device or the conversation?

Alexa Tepley
Briar Woods High School (BWH)

This study relates to human reaction time while talking on the phone via Bluetooth or hand-held. Is it the device or the conversation? The control was the reaction time of the subjects with no distraction. The independent variable was the reaction time and the dependent variables were the devices used with the conversation. There were a total of 100 human volunteers. Half of the participants were male and half female. They were all from the ages of 14 to 28. They took a reaction time test online first with no distractions as the control. Later again while engaging in a cell phone conversation via hand-held and last while engaging in a conversation via Bluetooth which were then compared to the reaction times of each volunteer when they had no distractions (the control). The results showed the central tendency while having a conversation using a hand-held device was 23% slower than the control and the central tendency while having a conversation using a Bluetooth was 15% slower than the control. Ones reaction time while having a conversation via hand-held was also shown to be 7% slower than if it were through a Bluetooth. Through the T-Tests in the statistical analysis the null hypothesis was proved to be rejected meaning that these results did not just happen by chance but that the dependent variable did have a statistically significant effect on the independent variable.

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The Affect of Multitasking on Reaction Time

Sarah Villalobos

Park View High School (PVH)

One may not realize that multitasking can affect how fast one reacts to something. It is actually very difficult to multitask even though most people would think it to be easy. And this experiment shows how. This experiment tested if simple everyday tasks make one's reaction time slower. The independent variables were the distractions: texting, eating, and talking. The dependent variable was the reaction time it took to react to the different distractions. The control was a non-distraction test. The subjects used in this experiment were humans, from ages 5-17, of both male and female in gender. The test was being done four times, with the first being the control and the other three with the three different distractions. The mean of the time it took to react to talking was 12.35 seconds. The mean of texting was 28.95 seconds. The mean of eating was 11.64 seconds. And the mean of the control was 6.24 seconds. The t-test showed that p>0.0001. The alternative hypothesis was stated that, if one is multitasking, then one's reaction time will be slower, and it was supported. Further research could explore which of the three distractions, texting, eating, or talking, is the most distracting. Even further research could be on how the affects would be on old people vs. young people like from ages forty and up and ages ten and down.

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The Effect of Color on Appetite

Catherine Vu

Park View High School (PVH)

The purpose of this experiment is to test the effect of color on appetite. This project is tested by dying a set of three sugar cookies. One set is not dyed (control), the second set is dyed orange, and the third set is dyed purple. Once they are dyed and baked, test subjects are asked to select a cookie of their choice. The independent variables in this experiment are the colors of the sugar cookies. The dependant variable would be the number of the people that selected a certain color cookie. Test subjects in this experiment are of no particular race, gender, or age. The mode in this experiment would be the sugar cookies that were not dyed. The results of the chi-square test in this experiment was x^2 of 10.4 > 5.99. Since the calculated value is greater than the table value, the null hypothesis is rejected. The alternate hypothesis in this experiment was “if sugar cookies are dyed orange or purple, then test subjects will find the orange cookie more appetizing because the color orange is known to stimulate hunger. This hypothesis was supported (not including the control). The independent variables did not affect the dependant variables as significantly as the control group. A major source of error in this experiment was including the control in this experiment (with the independent variables). Further research could explore the effect of color on ways of thinking.

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The Effect of Video Games on Speaking Reaction Time

Cynthia Vu
Park View High School (PVH)

Ever wondered if video games affect reaction time? This experiment tested whether video games affected speaking reaction time or not. The independent variable was whether video games were being played or not. The dependent variable was the amount of time it took to answer a question while playing video games. The control group was speaking normally without any video games. This experiment contained males and females, ages ranging from 14-60. This experiment was performed by asking subjects questions without video games and then asking them questions while playing video games. Times were recorded with a stopwatch. The means for the puzzle game reaction time difference and racing game reaction time difference were -0.2078 min and -0.27 min respectively. A t-test was used to find the significance of the means. The P value of racing game was 0.007 which was significant while 0.5 was the P value for the puzzle game which was not significant. The alternative hypothesis was if video games are played while speaking, then the amount of time it takes to answer a question will be delayed, and it was rejected because the games made speaking reaction time faster. However, the fastest reaction times resulted from the racing game. An error in this experiment could have been that subjects were aware they would be questioned beforehand. Further research could be done by testing physical reaction time with more video game genres.
The Effect of Video-Games on Spatial Orientation.

Timothy Wilson
Freedom High School (FHS)

Video games have many effects the brain, but does it include the improvement of spatial orientation? The independent variable for the experiment is video games, which could affect the time to complete a maze, which is the independent variable. The control chosen in this experiment was the non-video-gamers, which means that they play five or less hours of video games weekly. All participants were given 15 minutes to complete a maze. Afterwards, each participant was given a questionnaire asking how much video games he or she play weekly. The null hypothesis, which states that video games have no effect on spatial orientation, had to be accepted. Using a T-test assuming equal variance showed there was no significant difference between each set of data. The mean for the control, non-video-gamers, was 281.55 seconds and the video gamers was 228.875 seconds. The experimental hypothesis, which states that video games have an effect on the time to complete a maze, was not supported. The only possible major source of error would be cheating when participants were completing the maze. Would the results be any different if the maze was in 3D?

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The levels of vitamin C in Genetically Modified & Organic Strawberries (Fragaria ananassa)

Bradford Burke
Loudoun County High School (LCH)

The consumption of genetically modified versus organic Fragaria ananassa is valued for the nutrients in the products. There is little research that is available on genetically modified foods and nutrient loss. To test the vitamin C amounts in genetically modified versus organic strawberries, a method was developed that could compare the amounts of vitamin C in the two groups. A sample of one of the two types of strawberries was placed in a solution containing starch and iodine. When these three elements were added together a reaction occurred. The starch and iodine turned a blackish purple color, but the amount of vitamin C in the strawberry caused the color of the reaction to be lighter or darker purple. That solution was placed in a spectrophotometer, which produced a measured number, and then the samples from both genetically modified and organic strawberries were compared using each trial’s number that was produced. A T-test was used to determine that the organic strawberries contain significantly higher average vitamin C content when compared to the genetically modified strawberries. These results rejected the alternative hypothesis, which stated that the genetically modified strawberries would have a greater level of vitamin C than the organic strawberries. It rejected the null hypothesis that stated that the organic & genetically modified strawberries would contain the same amounts of vitamin C. Further research could investigate the vitamin levels in organic and genetically modified strawberries, further information into which type of strawberry is more rich in vitamins.

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The Effects of Aspartame Exposed to Heat on the Survival Rate of Saccharomyces cerevisiae

Che’ Maiah Francis
Stone Bridge High School (SBH)

Artificial sweeteners used as sugar substitutes help diabetic people control their blood sugar. The stability of aspartame is known to be affected at high temperatures. It breaks down into toxic metabolites (methanol, phenylalanine, aspartic acid where diketopiperazine DKP is formed as an intermediate compound).

The experiment tested if aspartame, exposed to high temperatures, decomposes to produce toxic metabolites affecting the survival rate of Saccharomyces cerevisiae, used as a model system (DNA repair enzymes in yeast and human cells are similar). If these byproducts are harmful to S. cerevisiae then, it will likely be harmful to humans especially to diabetics, infants, and people with phenylketonuria (PKU). Further investigation would be necessary to determine the safety of products containing aspartame.

S. cerevisiae (10E3 cells/mL) were incubated with 0.75mg/mL Aspartame heated (IV) at 100C, 150C, No heat for 4hrs (constant) and then 100µL was plated on YED. The average CFUs (DV) for unheated (control) were 199.9 (variance 636.69), for Aspartame heated to 100C were 201.1 (variance 1011.29) and for 150C were 19.2 (variance 10.16).

T test shows no significant difference (p>0.05) between CFUs of S. cerevisiae exposed to “unheated aspartame” and “heated to 100C”. There is statistically significant difference (P<0.05) in CFUs of S. cerevisiae exposed to “unheated aspartame“ and “heated to 150C” indicating either the presence of toxic byproducts of chemical reactions, or destruction of carbon source. ANOVA returns p<0.05 showing statistically significant difference between CFUs in unheated aspartame, heated to 100C and 150C with least number of CFUs in aspartame heated to 150C thus supporting the alternative hypothesis.

The future experimentation can explore the effect of pH on aspartame, and test if other sugars substitutes produce toxic metabolites when exposed to higher temperatures.

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The Effect of Tyramine on Amyloid-Beta Plaque Levels in Caenorhabditis elegans

Katherine Kamis
Dominion High School (DMH)
Academy of Science (AOS)

Alzheimer's disease is a degenerative disorder that attacks the brain's neurons. It causes behavioral changes and loss of memory, thinking, and language skills. One characteristic of Alzheimer's disease is the buildup of ß-amyloid plaque within the brain. A study by Heneka et al. concluded that increasing norepinephrine levels enhances ß-amyloid plaque phagocytosis. Tyramine, a trace amine found in the nervous systems of many animals, is known to release norepinephrine in addition to the invertebrate analog of norepinephrine, octopamine. Therefore, increasing the concentration of tyramine should decrease the level of ß-amyloid plaque. Experiments were conducted in Caenorhabditis elegans strain CL2006, a model system for Alzheimer's disease. The CL2006 strain expresses the human ß-amyloid peptide, which causes ß-amyloid plaque accumulation in the worm's body wall muscle cells. CL2006 worms were exposed to approximately zero, three, and six percent tyramine solution for two days. The amount of ß-amyloid plaque was assayed by staining the worms with Thioflavin S, a fluorescent dye that binds to ß-amyloid plaque. Statistical t-tests with an alpha of 0.05 on the first round of trials found no statistical difference in plaque content between the zero, three, and six percent tyramine solution concentrations. These results do not truly reflect the results of the experiment because of errors in capturing the fluorescence images and image processing. Experiments are underway to alleviate these problems. If tyramine is able to reduce ß-amyloid plaque through increasing octopamine, the invertebrate analog of norepinephrine, the results from the experiment could be applied to a human system.

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The Effect of Different Substances and Colors on Halyomorpha halys

Michael O’Mara
Loudoun Valley High School (LVH)

The purpose of the experiment was to test various substances and colors on Halyomorpha halys (Brown Marmorated Stink Bug) to conclude which were the best attractants and repellents. The Brown Marmorated Stink Bug is both a nuisance to home owners and responsible for millions of dollars of damage in agriculture products, it would be beneficial to find substances and colors that could either repel or attract the bugs to a certain location. The independent variables for the attracting substances were nine different color samples while the repellent testing had thirteen different substances. The control for both was a white sheet with no substance applied. The independent variables were each placed in an equal sized area in the testing grid. The high lights of the project were Cobalt Blue with a mean of 3.53 bugs and Onyx Black with a mean of 2.73 bugs. The top attracting substance was the stink bug pheromone with a mean of 3.23. The alternative hypothesis was supported with the colors and repellents while rejected with the attracting substances. The pheromone proved to be a reliable attractant. The results are beneficial to the project since it showed which colors and substances the bugs were best attracted to. In the future, it would be important to see if there was a greater amount of light reflected by either Cobalt Blue or Onyx Black.

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Zapped! The Utilization of Ultraviolet Light to Improve the Shelf Life of Produce

Caroline Pfohl
Woodgrove High School (WHS)

The rising cost of food and associated hunger in impoverished populations is directly related to food spoilage. The purpose of this project was to utilize the germicidal properties of UV-C light to extend the shelf life of produce in a countertop irradiation unit. Two identical countertop units were constructed. Fifteen grape tomatoes (Solanum lycopersicum), fifteen blueberries (Vaccinium cymbosum), and fifteen red grapes (Vitis vinifera) were placed in each unit. Produce in the irradiation unit was subjected to 30 minutes of daily UV-C irradiation. The experimental control was the produce having no UV-C exposure in the non-irradiation unit. Irradiation and non-irradiation units were kept side by side under identical environmental conditions. Produce weight, diameter, and visual quality were evaluated at days 1 and 12. Weight and diameter loss were calculated for each produce sample. Quantitative data analysis was accomplished for both weight loss and diameter loss using the unpaired two-tailed t-test. Qualitative data analysis was accomplished for changes in visual characteristics using Fisher’s Exact Test. A statistically significant diameter loss difference (p<0.05) was noted between all UV-C irradiated and non-irradiated groups. Weight loss differences between groups were significant for blueberries (p=0.0086). Significant color, shape and surface character differences were noted for grape tomatoes and blueberries (p>0.05). The hypothesis that UV-C irradiation extends the shelf life of produce was supported for blueberries and partially supported for grape tomatoes and red grapes. Further testing should emphasize varying amounts of UV-C irradiation and increased testing sensitivity to determine the degree of shelf life extension.

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The Effect of Polyphenol Antioxidants in Varying Vegetable Growth Methods - Organic, Conventional, Home Grown and Hydroponic

Amanda Presgraves
Tuscarora High School (THS)

In today's society, humans are offered countless varieties of a single food source. Organic, non-fat, low sodium, low calorie, natural, preservative free, locally grown, gluten-free; the list goes on. Misleading advertisements and information leave us confused - which option is truly the healthiest? Through experimental research conducted on lettuce and arugula, and the testing of multiple variables of each vegetable - home grown, organic, conventional, and hydroponic – a conclusion to this every day dilemma will be resolved. The determination of one’s “healthiness” is found through extraction of each vegetable’s phenolic content. The amount of polyphenols, an antioxidant, was found using a spectrophotometer to find the % absorbance values. The values were then compared to the gallic acid equivalence curve to accurately find how much polyphenols would be present. This experimentation data provided unexpected results, but nonetheless rejecting the null hypothesis with a p-value of 7.53E-06 for the lettuce and 1.26E-18 for the arugula, thus supporting the purpose of the study. The lettuce data concluded that home grown and conventional lettuce contained the same amount of polyphenols, followed by hydroponic and organic, with significantly lower values. The arugula data concluded phenolic content from greatest to least of organic, home grown, conventional and hydroponic, relatively. These results lead to further questions. There was an obvious difference of polyphenols between each variable, but there was no correlation between the lettuce and arugula. These differences could be due to either user error, or as data provides, it could in fact vary between vegetable. Dealing with such small measurement amounts follows a risk of easy error. Further research could use more scientific and technologically advanced equipment to finalize these results with accurate measurements that leave no possibilities for user error.

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The Effect of Melatonin on the Restoration of Circadian Function of Drosophila melanogaster

Perri Solthjou
Stone Bridge High School (SBH)

Circadian Rhythm is responsible for sleep, alertness, body temperature, digestion, hormones, immunity, and adaption to environment. Melatonin is a nighttime hormone that helps vital organs rest, and acts as an antioxidant. Sleep disorders result when melatonin is produced at the wrong time of day.

The experiment evaluated the effect of melatonin supplement (IV) followed by appropriate light cues (melatonin production is photoperiodic. It is initiated upon cues from eye, producing melatonin during darkness and inhibiting its production in light) on the restoration of Circadian Rhythm (DV) of Drosophila melanogaster.

After disrupting Circadian Rhythm with 24hrs continuous light (constant), ExperimentalGroup1 (Melatonin 12hr dark/12hr light) was compared with ExperimentalGroup2 (Melatonin 24hr light) and Positive Control (No Melatonin 12hr dark/12hr light) and Negative Control (No Melatonin with 24hr light).

Nine McNemar charts showed p>0.05 indicating no correlation in number of active D. melanogaster in 4 groups at 3 time frames (12:00am, 12:00pm, 8:58pm) thus refuting the alternative hypothesis. McNemar showed no correlation (p>0.05) in number of active flies “with melatonin” and “without melatonin” hence no restoration of circadian function of D. melanogaster indicating melatonin did not cause a beneficial effect. McNemar showed no correlation (p>0.05) in number of active flies “with melatonin with light cues” and “with melatonin without light cues” and “with melatonin with light cues” and “without melatonin without light cues” indicating appropriate light cues following melatonin did not restore circadian function of D. melanogaster.

Recording observations for longer duration might produce data which can used to study and restore Circadian Rhythm of blind people, travelers suffering from jet lag, or people working the night shift.

The further studies can investigate a technique to restore the circadian function of a patient with Seasonal Affective Disorder (SAD).

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## Cellular & Molecular Biology (400)

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The Relationship Between Light Intensity and Cellular Slime Mold (D. discoideum) Slug Migration

Timothy Bushman
Stone Bridge High School (SBH)

When the cellular slime mold D. discoideum slugs are migrating, they use light, heat and chemicals to orient towards the surface of substrate. The experiments tested what influences the slugs to orient during migration. One used light intensity and the extension used a wash from previous cultures to determine if extracellular signaling is important in slug formation and migration.

In the main experiment 12 cellular slime mold cultures in their migrating stage were placed in a box directly between two LED light sources of different brightness (IV). After 24 hours the migration of the slime mold culture was measured. Mean distance from the weaker light was 29.8 mm, and from the brighter light was 8.1 mm. Results of the t-test showed a P <0.05; the null hypothesis was rejected. The alternative hypothesis, "If D. discoideum is placed between two LED light sources it will then migrate towards the brighter of the two," was supported.

The extension experiment tested whether fully formed slugs could be influenced to migrate and spore on sterile paper disks. Results of the t-test show a P-value of P <0.05. The hypothesis was supported that significantly more slugs will spore on disks soaked with the extracellular wash compared to disks soaked in water.

Further research could look at how the D. discoideum detects and orients itself towards the brighter light source.

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The Effect of Sucrose on the Hyperactivity and Regenerative Ability of Planaria

Naga Deepak Chelluri
Briar Woods High School (BWH)

Does a diet high in sucrose cause hyperactivity in humans and other organisms? In this experiment, planaria were used since they have similar body structure and nervous systems as do humans. The purpose of this experiment was to determine the effect of sucrose on hyperactivity and regenerative ability in planaria. The null hypothesis was if the sucrose concentration increased, the hyperactivity in planaria would not change significantly. The independent variable was sucrose concentration, which was tested at the following five levels: 0.0 (Control), 0.001, 0.002, 0.003, and 0.004 grams per milliliter. The dependent variable was hyperactivity and regenerative ability, measured in the average distance travelled (mm) during 4 minute period. Regeneration was measured through observation. The constants of the experiment were the volume (10 mL), type (spring water), and temperature (room). The major finding of this experiment was that as sucrose concentration increased, hyperactivity increased significantly. Planaria in the 0.004 grams per milliliter sucrose concentration exhibited a greater mean distance travelled (130.67 mm) than planaria in the 0.0 grams per milliliter (31.67 mm), 0.001 grams per milliliter (64.00 mm), 0.002 grams per milliliter (78.33 mm), and 0.003 grams per milliliter sucrose concentrations (128.67 mm). The ANOVA test reject the null hypothesis (F = 92.71 > 2.5 at df(4, 70); p = 3.254948E-27 < 0.05). Supporting the experimental hypothesis: increase in sucrose concentration, increases hyperactivity, but has no effect on regeneration. Given the association between sucrose consumption and hyperactivity, policymakers can aim to promote diets which reduce sugar intake.

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Analyzing the Mechanisms behind the Anticancerous Properties of Hypericum perforatum on the Growth of a Mouse Mammary Cancer Cell Line

Ashley Ferguson
Stone Bridge High School (SBH)
Academy of Science (AOS)

Caitlin Morris
Dominion High School (DMH)
Academy of Science (AOS)

Cancer cells have been found to exhibit an upregulation of glycolysis which results in an increase in cell proliferation. Thus the inhibition of glycolysis has been shown to be a potential target for cancer treatment. Aldolase and enolase are two key enzymes involved in the process of glycolysis. We report here the ability of H. perforatum to inhibit the growth of mouse mammary cancer CRL2539 cells through the inhibition of glycolysis by inhibiting or denaturing the proteins aldolase and enolase. H. perforatum at concentrations (mL of extract per mL of media) of 0.4% and 0.8% significantly reduced the amount of aldolase and enolase (P<0.05) in the mouse mammary cancer cells. In addition, the amount of aldolase and enolase in H. perforatum at a concentration of 0.8% compared to H. perforatum at a concentration of 0.4% is under study. Our study shows a promising therapeutic strategy in using the whole H. perforatum extract as its own form of treatment to effectively slow the growth rate of cancer cells through the inhibition of glycolysis; potentially overcoming the negative side effects associated with current forms of cancer treatment.

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The Effect of Removal of Rad52 (HR defective), Yku70 (NHEJ defective), and Rad52 Yku70 (HR and NHEJ defective) on the Ability of Mutant Strains of S. cerevisiae to Repair Oxidizing Agent-induced DNA Double Stranded Breaks

Erin Green
Stone Bridge High School (SBH)

Double stranded breaks (DSBs) in DNA may result in genomic instability that can lead to cancer or cell death. The experiment investigates the contribution of genes rad52 and yku70 in DNA repair of oxidizing agent-induced DSBs by homologous recombination (HR) and non-homologous end joining (NHEJ).

The mutant strains of S. cerevisiae rad52 (HR-defective), and yku70 (NHEJ-defective), and the rad52yku70 (both HR and NHEJ-defective) were exposed to 37°C (thermal disruption IV), H2O2 (IV). The DSBs induction, repair and survival rate (CFUs DV) of mutants was compared to wild type and individual positive controls (30°C and with sterile water).

T test did not show significant difference (p>0.05) in WT (30°C–37°C), rad52 (30°C-37°C) and rad52yku70 (30°C-37°C), WT37°C–rad52 37°C indicating oxidative damage caused by thermal disruption is efficiently repaired by wild type and HR defective strain. The absence of rad52 does not affect DNA repair and survival rate. T test shows statistically significant difference (P<0.05) in CFUs of yku70 (30°C–37°C) and WT37°C–yku70 37°C and WT 37°C–rad52yku70 37°C indicating oxidative damage caused by thermal disruption is not sufficiently repaired by NHEJ defective strain. The absence of yku70 affects DNA repair and survival rate.

Yku70 repairs DNA by NHEJ when repairing DSBs essentially annealing the ends of the strand of DNA without the use of a template. Yku70 has increased sensitivity to heat. ANOVA returns P<0.05 showing statistically significant difference in CFUs of wild type and mutant strains exposed to 37°C. The least CFUs was found in rad52 yku70 thus supporting the alternative hypothesis.

Future research will test effect of UV rays on defective rad52 mutant strains’ ability to repair DSBs.

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A Comparison of the Mutagenic Activities of Extracts of Tobacco

Kenneth Kuhn

Briar Woods High School (BWH)

The purpose of this project was to measure the ability of human saliva and drinking alcohol to extract mutagenic carcinogens from cigarette smoke particulates, and to define the effect of alcohol and saliva combined as an extractant. Samples of human saliva, drinking alcohol and a combination of the two (levels of independent variables) were used to extract chemicals from cigarette smoke condensate collected using a simple smoking machine. The mutagenic activity induced by the extracting chemicals (dependent variable) was measured using the Ames test. The results showed that both human saliva and alcohol extracted mutagens, with alcohol extracting more than twice as much as saliva. The project also tested whether the extraction ability of alcohol and saliva is additive when used together to extract condensate. The results showed that saliva and alcohol are not synergistic and produced extracts that induce a mutagenicity level similar to that of alcohol alone. The project results indicate that both saliva and drinking alcohol remove mutagenic carcinogens from tobacco smoke condensate, but that saliva is far less effective than alcohol. The project results suggest a molecular mechanism to help explain how smokers who drink alcohol could be exposed to a much greater level of mutagenic carcinogens than smokers who do not drink alcohol. Future research could investigate the effect of individual variation by using saliva from different people, and the effect of other types of tobacco products such as cigars and pipes.

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Down-regulation of the CYP1A1_CYP1A2 Gene Locus by Estrogen-Receptor Interaction with Estrogen Responsive Elements

Leslie Mark
Dominion High School (DMH)

Cytochrome p450 (CYP) enzymes play an important role in the detoxification of many harmful substances in the body, while activating others. CYP1A1 and CYP1A2 genes are oriented head to head on chromosome 15, share regulatory regions, and contain the palindromic sequences GGTCA [Nn] TGAC/TC. Estrogen response elements (EREs) lie between the two genes and are thought to play a role in the up or down regulation of certain genes when bound with the estrogen receptor.

The purpose of this research was to determine whether interaction between estrogen-receptor (ER) and estrogen responsive element (ERE) could, in addition to causing up-regulation, also cause the down-regulation of the CYP1A1_CYP1A2 gene. This was assessed by evaluating a series of CYP1A1 and CYP1A2 EREs and both positive and negative controls with electromobility shifts assays (EMSAs). This process revealed that several CYP1A1 and CYP1A2 EREs interacted with ER. The effect of estrogen on CYP1A1_CYP1A2 gene transcription was evaluated with a Comparative CT study in primary hepatocytes utilizing RT-PCR. Significant down-regulation in the presence of estrogen was demonstrated and could be eliminated by addition of anti-estrogenic substances. Since this locus is implicated in transforming a number of substances into carcinogens, investigation of the CYP1A1_CYP1A2 gene locus and its down-regulation by ER is integral in understanding estrogen’s role in the regulation of genes. The results of this research give an optimistic view of what the future holds in regards to reducing carcinogens in the body and potentially cancer prevention.

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## Chemistry (500)

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The Effect of Different Colors of Light on Sun Print Paper

Tamanah Anwari
Woodgrove High School (WHS)

The purpose of this experiment is to advance the field of photography by producing brighter images simply with the sun's rays. To gain this knowledge, the effect of different colors of light on sun print paper was tested. The different images made were compared to the control— the sun print paper exposed to all colors of light. The image was made by placing the paper in direct sunlight. During the experiment, different colored plastic was held over the paper so only that color filtered through. It was found that the lower the wavelength, the brighter the image would become. The means were also found for the different groupings. Clear, or the control, had a mean of 54.5 lux, red 56.2 lux, orange 57 lux, yellow 57.6 lux, green 58.5 lux, blue 91.3 lux, and violet had the highest mean at 92.4 lux. The results for the statistical tests were not significant because no pattern was evident. The hypothesis for this experiment was that if the wavelength of the different colors of light increased, then the brightness of the image would increase. This was not supported by the data. Still, the independent variable, different colors of light, impacted the brightness by making it brighter compared to the control. This is because the shorter the wavelength, the more energy that color of light has, creating a more luminous piece. Further research could be made on how the sun at different times of day affect an image using the different colored plastic.

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The Effect of Flavonoids on the Rate of Decomposition of Hydrogen Peroxide

Catherine Chantre
Briar Woods High School (BWH)

The purpose of this experiment was to determine if Flavonoids, a type of antioxidant, could slow the oxidation-reduction process. In this experiment, different types of Flavonoids were tested to see if they could slow down the decomposition of hydrogen peroxide that was being catalyzed by potassium iodide. The different types of Flavonoids served as the independent variable and the dependant variable was the rate of decomposition of the hydrogen peroxide solution. The control was the solution of hydrogen peroxide and potassium iodide only. What occurred was that each type of Flavonoid was added to the reaction and it was then tested whether or not they slowed the reaction. The three types of Flavonoids used: kiwis, apples, and red tea all had significant effects on the reaction. The red tea and kiwi slowed it down significantly while the apple at times increased it. With the results of the initial rate of each type of reaction, statistical analysis proved the results significant and showed that red tea had lowered the reaction the most. The averages of the control, kiwi, apple, and red tea were 0.0971, 0.1034, 0.1304, 0.0723 (kPa/s) respectively. A T-test was also performed which compared the results of each Flavonoid to the control. Through the results, Flavonoids did have an effect on the slowing of the oxidation-reduction process however only two out of three performed the desired effect. In future experimentation, if this test could be performed in a living organism, this would demonstrate even better the effect of Flavonoids.

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The Effect of Temperature and Salt Concentration on the Fermentation Process of Kimchi

Kyle Chung
Briar Woods High School (BWH)

The experiment's purpose is to test whether or not salt concentration (IV) or temperature (IV) affects the pH (DV) of kimchi. Is it simply comfort food or a need to preserve the culture? This experiment was tested through a span of a week, which the experimenter measured the pH and glucose of the kimchi each day in two climates (room temp. & cold temperature). The experimenter is then able to see if salt is capable of negating the effects of temperature during the process of fermentation. The results proved that salt barely played a role in the fermentation process, which makes the control (240g salt) non influential, unlike temperature, which drastically decreased the pH faster in room temperature than in the cold setting. The means ranging from 4.6-4.9pH (cold temperature) compared to 3-3.6 (room temp.) clearly proved that room temperature quickens the fermentation process of the kimchi. With a t-test, the experimenter can accept the null hypothesis (the pH of the kimchi decreasing as the temperature and salt concentration increased) which both variables compared to the control proved to be greater than 0.05 no matter the temperature. The experimental hypothesis was accepted which the pH was clearly higher in colder temperatures. The wrong temperature during fermentation could have created a source of error. But can factors like length of the fermentation process, alter one’s results?

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The Effect of Various Chocolate Bars on Heating Time (sec)

Justice Colbert
Park View High School (PVH)

Is heat the only factor of chocolate melting? That is why this experiment was conducted: to test if the different types of chocolate will have varying melting times. The independent variables are the Hershey’s Milk Chocolate, Cookies ‘n’ Cream, Special Dark Chocolate, and Milk Chocolate with Almonds. The dependent variable was the melting times of the chocolates. The control was the Baker’s Chocolate. The chocolate was placed on a stove to melt. The means of the chocolate were 67.54 seconds for the milk chocolate, 89.28 seconds for the cookies ‘n’ cream, 102.58 seconds for the special dark, 67.91 seconds for the milk chocolate with almonds, and 126.59 seconds for the baker’s chocolate. The majority of the independent variables influenced the dependent variable, with the exception of the milk chocolate and the milk chocolate with almonds. The t-test showed that those two did not differ; they had a P value of 0.4541. The others had a P value of less than 0.001 which means that the variables were significantly different. The alternative hypothesis, If the melting times of Hershey’s Milk, Cookies ‘n’ Cream, Extra Dark Chocolate, and Milk Chocolate with Almonds are tested, then the time it takes to melt the chocolate will vary, was supported. Further research could be conducted evaluating different brands of chocolate. Sources of error include temperature changes of the place where the experiment was conducted.

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The Effect of Time Sweet Potatoes are Cooked on the Amount of Vitamin C Content

Helena Ezzeldin

Broad Run High School (BRH)

The purpose of this experiment is to determine the effect of different cooking methods on the amount of vitamin C content the sweet potato contains. In order to perform this experiment I cooked three different batches of sweet potatoes, each batch with a different cooking time. The cooking times were 15 minutes, 30 minutes, and 45 minutes. Once cooked for the determined time I than began to measure the amount of vitamin C content each batch contained, through a titrate mixture using iodine solutions. My data concluded that my hypothesis was not supported by the conclusion of my experiment. My data and p value shows that the more time the sweet potatoes were cooked the more vitamin C content it contained.
The Effect of Sodium Bicarbonate on the Fire Retardant Potential of Paint

Saadiq Hasan
Broad Run High School (BRH)

The study relates to inorganic chemistry. The purpose was to find out how sodium bicarbonate in paint could stop the dispersion of fire, ultimately leading to saving lives and the hundreds of homes and buildings that burn every year. The independent variable was the amount of bicarbonate used in each sample. The dependent variable was the time of ignition of the drywall. The controls were the type of paint, amount of paint, the brush, and the stopwatch. The method was to put different amounts of bicarbonate in paint and then light the painted surface of the drywall on fire to see if the sodium bicarbonate hindered the dispersion of the lit drywall piece. The results when processed through many Pearson r Tests yielded that the R-Values were less than .45 meaning the groups had no correlation to one another. The means for the groups are, control 25.3, 4gms of bicarbonate 25.2, 8gms 37.2, 12gms 57.3 respectively. The results from the Pearson r Test made the alternative hypothesis that was if sodium bicarbonate is mixed in paint then it will impede the dispersion of fire. The IV did not affect the DV because the amount of bicarbonate added to paint did not correlate with the time of ignition. A possible error while conducting this experiment was the method to ignite the drywall. Further research could explore how other chemicals mixed in with sodium bicarbonate in paint could hinder fire, and can there be a more precise way to test the experiment.

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How the Antioxidant Properties of Cloves Affect the Patina Process of Copper

Saajid Hasan
Woodgrove High School (WHS)

Over the years, antioxidants have been advertised as a miracle substance. They have the ability to delay the oxidation reaction that occurs in humans (aging). But can the antioxidants affect the oxidation reaction that occurs in copper, known as the patina process? To test this, ten buckets were set up containing six pieces of copper each. To 30 of the copper pieces, cloves (an antioxidant rich spice) were applied. The independent variable was the adding of the cloves and the dependent variable was the growth of patina. The control group was the 30 pieces of copper with no cloves applied. After six weeks, data was collected. The mean of the control group was 2.2 millimeters of patina growth, while the mean of the copper pieces with cloves was 0.72 millimeters. The standard deviation of the data for the control was 0.57 while for the copper pieces with cloves it was 0.35. The hypothesis was supported in this experiment. The pieces of copper with cloves applied had a much less growth of patina, indicating that the antioxidant rich cloves helped delay the oxidation process, indicating that the independent variable had an effect on the dependent variable. Other ideas to consider would be the antioxidant properties from other substances such as lemons. Further research could explore the effect of antioxidants on different chemical reactions.

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The Effectiveness and Environmental Impact of Different Flame Retardants on How Long it will Take for a Fabric to Catch Fire

Anush Karnati
Freedom High School (FHS)

Today much of the world’s environment is affected by toxic chemicals. Many of these chemicals come from toxic flame retardants. Recently, new flame retardants came out claiming to be effective and environmentally friendly. The purpose of this experiment was to find if new flame retardants could be effective and environmentally friendly, and explore other solutions with capabilities of retarding flames. To determine the effectiveness of the solutions, a fabric was coated with different solutions (Independent Variable). The fabric was then ignited, and the time taken to extinguish was recorded (Dependent Variable). The control group was fabrics that were not coated with the solutions. The Class A Flame Retardant was found to be the most effective, with an extinguishing time of 2.69 seconds. The others groups’ times were 2.65 seconds (Borax-Boric Acid Solution), 2.47 seconds (Green Class A Flame Retardant), and 1.06 seconds (Control Group). The T-Test was performed on the data. The environmental impacts of the solutions were determined by researching chemicals used in making each of the solutions. It was determined that the Green Class A Flame Retardant used was the most environmentally effective. The alternative hypothesis was, if we used a Class A Flame Retardant, then the spread of flames would be retarded for a longer period of time. The hypothesis was supported by the data. The results mean that flame retardants can be both effective and environmentally friendly. Further research that can be done is if flame retardants can be as effective on other types of materials.

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The Effect of Climate Temperature on the Amount of Glow Time of Luminol Sticks

Ashley Long
Park View High School (PVH)

This experiment tests the effect of the climate on the glow time of the luminol sticks. Luminol sticks were placed in water at twenty degrees Celsius (the control), water at forty degrees and water at negative twelve degrees Celsius, the independent variables. Once the luminol sticks died, the time was recorded; a thermometer was used to measure the temperatures but due to error they could have changed. This was to see if the amount of time that the luminol sticks glowed, the dependent variable, would vary according to the climate. If a tube filled with luminol (glow stick) is placed in a pan of ice cold water, then the glow effect of the luminol will last for a longer time than at room temperature or in warm water, which was supported by the data. The mean of the control, 3533.33 seconds, which was higher than the mean of the warm luminol sticks, 1178.58 seconds, and lower than the mean of the freezing luminol sticks, 31470.22 seconds. The P values of the experiment showed that there was a significant difference from the control. This shows that it would be unlikely that the outcome will ever be equal to the mean. The experiment statistical data supported that with lower temperature, the longer the glow time lasts and the higher the temperature, the shorter the glow time will last. If the effect of temperature was tested in other chemical reactions, then scientist could apply this to other aspects of science like anthropology.

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The Effect of Ammonia Levels in Hair Dye on Hair Textures

Cailey Oswald
Woodgrove High School (WHS)

The purpose of this experiment was to test whether ammonia levels in hair dye and hair texture affected its longevity. Ammonia and ammonia free hair dye were compared on straight and curly hair. The independent variable was the type of hair dye. The dependent variable was the number of washes to initiate fading of the dye. The control groups were the samples of hair that were dyed and not washed. The samples were dyed and then washed until the color started to fade. The hair dye containing ammonia lasted an average of 34 washes on the straight hair and 31 on curly hair. The ammonia free dye only lasted an average of 23 washes for both straight and curly hair. The ammonia dye on curly hair had the highest standard deviation at 3.094. The ammonia free dye had the lowest standard deviation at 1.685. The ammonia dye on straight hair had a standard deviation of 2.576. The ammonia free hair dye on straight hair had a standard deviation of 2.35. The first part of the hypothesis, if hair dye containing ammonia is used on straight hair, then the color will last through more washes, was supported, but, if hair dye without ammonia is used on curly hair, then the color will last through more washes, was refuted. Overall, the hair dye containing ammonia had a greater longevity. This project could be taken further by adding another element, such as different hair color or brands of hair dye.

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The Effect of Different Chemicals Used to Make Cold Packs on Lowering Water Temperature

Cameron Robinson
Stone Bridge High School (SBH)

A cold pack can be used in situations and places where energy or electricity is not available to make ice. The purpose of the experiment was to determine which chemical is most efficient in lowering the temperature of water in a shorter period of time during an endothermic reaction and can be used to make an instant cold pack.

10 grams (constant) of each chemical (IV), Ammonium Chloride, Ammonium Carbonate, or Sodium Thiosulfate, was mixed into the 50mL distilled water (constant) and the temperature (DV) was recorded every 5sec using the temperature probe until the temperature was stable. The duration of the time taken to lower the temperature until it stabilized was recorded in seconds (DV), and the rate of change of temp (degree Celsius/min) was calculated by multiplying the total decrease in temp (difference between initial and final temperature) by 60 and divided by time period (sec) taken to lower the temperature.

The average rate of decrease in temperature for Ammonium Chloride was 5.8°C/minute (variance of 2.63), Ammonium Carbonate was 3.41°C/minute (variance of 0.84), and Sodium Thiosulfate was 3.11°C/minute (variance of 0.46).

The ANOVA returns p<0.05 indicating statistically significant difference in the rate of decrease in temp by all 3 chemicals. Ammonium Chloride had lowered the temperature in a shorter period of time and had highest rate of decrease in temp than other chemicals, thus supporting the alternative hypothesis. Ammonium Chloride reacts with water and the endothermic reaction absorbs the most energy as compared to other chemicals.

Further studies can explore chemicals that can increase the temperature to find the most efficient and safe chemical to use in hot packs.
How Do Different Environments Affect the Speed at which Cheese Molds?

Nicholas Smith
Park View High School (PVH)

The purpose of this experiment was to see in which location was it best to keep cheese in a refrigerator. Ten cubes of cheese were placed in 3 locations in a refrigerator cheese and butter and vegetable drawers. The independent variable was the location of the cheese the dependent was the amount of mold. The control was the cheese drawer. The t-test resulted in 0. The means of the drawers were .133, .133, and 0. The p-value was .895 which meant there was little difference between the drawers. If the 4cm x 4cm x 4cm blocks of sharp cheddar cheese are put in a cheese drawer of a refrigerator, then they will last longer than the cheese in the butter drawer and the vegetable drawer was the alternative hypothesis and it was not supported. The independent variable did not influence the dependent variable and they were the same as the control group. The cubes of cheese had to be cut from different blocks of cheese which could have caused error or that the cheese dried out instead of molded. Any further research that is done would want to consider covering the cheese and testing more test subjects.

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The Effect of Water, Coca Cola®, White Vinegar, and Industrial Grease Remover (Goof Off®) on vegetable oil.

Cody Tippett
Park View High School (PVH)

It is hard to remove grease from pans. This experiment was done to find which chemical will remove the most grease. The independent variables are water, Coca Cola® soda, white vinegar, Goof Off®. The dependent variable is the amount of grease left in the ramekin measured in grams. The control group is 5 ml of water soaking on top of the grease for 1 minute. First the grease was measured (5 grams) then the chemical was measured (5 milliliters) and that was poured onto the grease. Then after 10 minutes the chemical was poured out of the ramekin and that was measured with the grease left in it. The averages for the chemicals are water: 0.86 grams, Coca Cola®: 0.607 grams, Vinegar: 0.56 grams, Goof Off®: 0.327 grams. The chemical that removed the most grease was Goof Off®. The ANOVA statistical test was used. The P Value of the data was 0.000 therefore the null hypothesis was rejected. The hypothesis was if a ramekin with Wesson® vegetable oil on it is soaked with 5ml of vinegar, then the grease will come off of the ramekin better than if the ramekin was soaked with water, Coca Cola® or Goof Off®. It was not supported by the data. The independent variables did influence the dependent variable. The control group did measurably worse than the rest of the independent variables. One major source of error would be human error, such as no measuring the right amount of chemicals. If this were to be furthered one might consider studying the difference in temperatures of the chemical.

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The Effect of Thymol or Formic Acid Based Miticides on Honey Bee (Apis mellifera) Hive Populations

Justin Virts
Woodgrove High School (WHS)

Beekeeping is something only a few privileged and fortunate people undertake, and unfortunately is becoming one of the most difficult hobbies. Varroa mites are decimating honey bee (Apis mellifera) hives, and concoctions are being created worldwide in a desperate attempt to stop the parasite. This experiment was conducted to test the effectiveness of the two leading active ingredients, thymol and formic acid, against the advertised kill ratio for mites. Each miticide was tested on 30 different hives to observe which would lower the mite population most effectively, and a control group was tested without receiving treatment. Prior to treatment, an initial mite count was taken for each hive, and after one cycle for each miticide treatment, or two weeks for the control group, a final mite count was taken. The total percent of mites killed in each hive was then recorded and all the percents were averaged. Thymol killed 26.45%, formic acid killed 30.08%, and the control saw an increase of 13.99%. The results support the proposed hypothesis that the formic acid based miticide would have an increased affect in mite death rather than the thymol based miticide. The hatching cycle of the honey bees is a possible source of error, but the experiment was designed to avoid this possibility as much as could be controlled. This experiment raises two questions: Is there a better treatment than the two recommended methods? Is there a more natural method that is efficient? The only way to find out, is to test it.

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The Effect of Sodium Chloride vrs Calcium Chloride on the Freezing Point of Water

Melinda Waterman
Broad Run High School (BRH)

Winter brings danger in the form of ice, which can cause accidents on the roads. NaCl, known also as sodium chloride, is used on icy roads because the separation of ions in NaCl disrupts the Hydrogen bonds contained in water and melts the ice. This experiment tests whether NaCl, or a different salt, CaCl2, would lower the freezing point of water more. The independent variable is which salt is the solute in the solution being tested. The dependent variable is the freezing point of the solution. The control is the freezing point of distilled water. To begin the experiment, an ice bath with rock salt added should be prepared in a bowl. In turn, each of the solutions should be placed in the ice bath and the temperature monitored in degrees Celsius until the solution freezes. The results of this experiment are as follows: the solution of CaCl2 has the lowest freezing point as compared to the control and the NaCl solution, and the control group has the highest freezing point. The mean freezing point for the CaCl2 solution is -5.92 degrees Celsius, for the NaCl solution is -5.04 degrees Celsius, and the control is -0.44 degrees Celsius. The T test showed that the null hypothesis was rejected and the experiment was conclusive because the probability of error is less than the level of significance. The hypothesis was supported due to this. Further research could explore the cost of NaCl versus CaCl2 in looking at real world application of the results.

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Increasing Productivity and Cost Efficiency in Taxicab Dispatch via Java Program Implementation of Linear Programming

Alexander Chou
Dominion High School (DMH)

The taxi cab is one of the most popular public transportation services employed around the world. With such a high demand for their use, taxi cab companies look to minimize costs and maximize profit. One such way of minimizing costs in running taxi cab companies is to assign taxis to customers in a more efficient manner.

The purpose of this research was to create a computer program that could analyze the distance from each taxi in service to each customer and decide which taxi to assign to which customer so taxis can move in the most cost efficient manner as possible. In most cases, the best assignment is not clear by just looking at the list of distance values from each customer to taxi. To solve this assignment problem, linear programming (LP), a mathematical technique used to optimize values under certain conditions, was applied. Algorithms were written in Java programming language to simulate the methods of linear programming and derive the optimal solution.

With the computer program created, users can easily and quickly assign taxis to customers. This allows efficient transport of passengers while minimizing the total distance traveled and hence cost while taxi cab drivers are not holding customers. Also, decision-making can be accomplished in only a matter of seconds. Further research on a taxi dispatcher program would entail the expansion of the multidimensional array so the program could hold a larger number of taxis and customers.

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Application of Digital Elevation Models for Floodplain Delineation and Analysis

Ahnaf Choudhury
Freedom High School (FHS)
Academy of Science (AOS)

Current evidence suggests both a continuing rise in world sea levels as well as significant changes in global climate patterns. As a result, efficiency in creating and analyzing floodplain models has become increasingly important. Digital elevation models (DEMs) developed using remote sensing technology can be utilized to produce accurate floodplain models for dam-breach analysis while circumventing the need for costly and time-consuming topographic surveys. Data collected from a major government DEM database was input into geographic information system (GIS) software for spatial calculations and data preparation, after which a detailed unsteady-flow analysis was conducted using HEC-RAS for hydraulic modeling and floodplain delineation. The efficacy of the resulting model was substantiated through a comparison with an existing land survey-based model for the same region. If Federal Emergency Management Agency or a similar authoritative body deems that a topographical survey is essential for optimum accuracy, a DEM-based model can be used to provide an effective preliminary flood-risk assessment while topographic elevation data is being collected. In addition, the proposed method makes it possible to create reliable flood-risk reports in remote locations anywhere in the world where a topographic survey may not be entirely feasible.

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Effects of Parabolic Mirrors on the Time a Wireless Router Can Send and Receive Data

Colm Gallagher
Broad Run High School (BRH)

The IEEE’s 802.11 wireless internet system, better known as Wi-Fi or WLAN, was invented in 1997. Over the past 14 years, the technology has become more advanced and widely used across the world. 802.11 uses an access point (AP) to connect to the internet. The most common AP is a wireless router which differs in speed and range based on the model. This experiment was conducted to determine whether the use of a parabolic mirror, acting as a reflecting dish, could increase the rate to send and receive a wireless transmission. By using a parabolic mirror with the dimensions 5x5x3.5cm and a focus at 0x0x0.446cm, the experiment tested whether the reflective property of a parabola could further the development of wireless networking by placing the mirror near the transmitter of an 802.11g router. Using the supplied Command Prompt on a Microsoft Windows PC, this experiment pinged, or sent a wireless message, to its connected router and determined the time in milliseconds for a return. This was done 100 times on a constant with no mirror, one with the parabolic mirror placed .446cm below the transmitter, and one with the parabolic mirror placed 1cm below the transmitter. The averages of the test with parabolic mirrors were significantly smaller than that of the test without. Also, a t-test performed rejected the null-hypothesis and thereby proved this experiment to be valid with less than a 5% chance of error. This data could possibly lead to the further development of a more effective wireless 802.11 router.

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Analysis and Detection of a Direct Kernel Object Manipulation Exploit

Austin Garrett
Dominion High School (DMH)

Many threats exist to the safety and security of information on computer systems via connection to the internet. Many new types of exploits have been discovered to circumvent the normal processes of a system that have little to no method of detection. The purpose of this research was to determine a method in which to detect a direct kernel object manipulation exploit which skewers the running processes on a computer. Various classes of java code were written to compare the processes and connections of an exploited system to those of an unexploited system to determine differences and ultimately a way of detection.

Analysis of the comparison between the exploited and unexploited processes and network connections determined that when the exploit ran, even though the process appeared to be gone, the network connection remained. The reason for this connection was because the unlinked process was simply hidden but still ran normally. The only way for the process to run normally was through these connections to the network. Through this analysis, code was written which automated the comparison process and displayed whether or not the exploit existed. Hence, a method of detection was created. Further research using different network processes enhance information code reliability in the exploit detection. This research is important to corporations and government organizations that need to protect information from hackers. With the development of this method of detection, light has been shed on the direct kernel object manipulation exploit.

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In this experiment the frame rates of three graphics cards were compared. The frame rate determines how many frames per second can be displayed on a monitor. In the project, the Heaven DX11 Benchmark program was used to test the frame rate of the graphics cards. The graphics card was the independent variable, and the frame rate was the dependent variable. The three graphics cards were the NVIDIA GeForce GTX 460, the Radeon x1950 Pro, and the ATI Radeon HD 4870. The data was recorded in frames per second (fps). The mean fps of the NVIDIA 460 was 35.02. The mean fps of the Radeon x1950 was 2.62, and the mean fps of the Radeon 4870 was 31.59. An ANOVA test was used, and the null hypothesis was rejected. The alternative hypothesis is that the frame rates will be different, and it was supported. The results show that the frame rate is dependent on the architecture of the card. The clock rate also determines the frame rate. There is a master clock in a graphics card. It controls the speed of the card. The clock rate can be sped up or slowed down. This will either raise or lower the frame rate. Other experiments could be done to test the limits of a card’s clock rate.
The Effect of Introducing an Electronic Employee Scheduler to a Business

Fintan Kelly
Loudoun Valley High School (LVH)

The purpose of this experiment was to see if an employee scheduler will reduce the amount of time needed to complete schedules and increase their efficiency. This experiment focuses on the business hours per day, business days per week, shifts per day, and number of employees as the independent variables. While the dependant variables include; shifts per day, employees per shift, and employee hours. To replicate this experiment, one must create a set of values and then mathematical equations to create the weekly schedules. Results for this experiment were interesting, the amount of time needed to complete this was small and the efficiency was absolute. The end-product of the schedules was organized well. As a total, four to six employees worked five days a week and to two to six worked four days a week and the total number of hours corresponded with 40 and 32 hours. The original hypothesis of this experiment was supported with the results. Also, the independent variables directly influenced the outcome of the dependant variables. More in-depth experimentation would reveal possible advancements such as; the ability to link the program to a paying system; or to an emergency call system when an employee is absent. Other questions remain such as; how to incorporate large numbers of employees.

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It’s that time of day, you’re commuting back home, stuck in this painful traffic jam. The radio is blaring the worst sort of music. This project uses Java in order to figure out what is the most ideal way to control and configure a traffic jam for there to be less congestion.

The independent variables are the different traffic patterns [all of the lane blocked, part of the lane blocked, or no blockage (control)], car flow, and speed of cars. The program was set up to run 15 trials for 27 different conditions. The results supported my research hypothesis which stated that it is better to block a whole lane, rather than let the cars merge at the congestion point no matter the speed or car flow. The average amount of time for each of the set ups ranged from 900 to 2000 seconds taken for a car to run through the simulations. The independent did affect the dependant variable, rejecting the null hypothesis through the T-Test. Some possible sources of error can be caused by excluding any human psychology that occurs while driving.

This research will hopefully encourage the Department of Transportation to further look at how to block a whole lane in efficient manner if a whole lane was blocked. What kind of infrastructures would be ideal for controlling lane blockages.
Optimizing DNA-Based Data Systems in E. coli Containing Encrypted Quaternary or Binary Data

Daniel Valenzuela
Dominion High School (DMH)
Academy of Science (AOS)

Research has been done into creating data systems based on the DNA sequence of plasmids in bacteria. Various researchers have done both theoretical and experimental research into devising schemes to create a bio-hard drive, with some successfully being able to encode short phrases into DNA sequences by using nucleotide bases as representations for bits of data. The research being presented focuses on theoretical models describing how a DNA-based encoding scheme will affect data embedded into plasmids. Specifically, it focuses on how certain coding schemes can be affected by sequence length and the number of DNA replication cycles as mutations are inherent in the latter factors. The goal is to optimize coding schemes such that they are robust against mutations and intrusions by unauthorized people, and that they contain the highest density of characters per nucleotide base. The type of data used (quaternary or binary), the encryption used, and the error-correcting codes are all tested through mathematical modeling to determine the optimal coding scheme. So far, a base model has been created that determines mutation rates and the number of mutations based on sequence length and the type of data being used (i.e. quaternary or binary). Further background research needs to be done on coding schemes to build sophistication on the base models.

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The Effect of Data Compression on the Sound Quality of an MP3 file

Louis Wilson
Loudoun County High School (LCH)

This experiment researches the effect of varying levels of MP3 algorithm compression on an audio file’s overall sound quality. The way this kind of compression works affects millions of people on a daily basis. In order to measure the effect of MP3 compression on sound quality, 30 songs were selected and 3 levels of compression were applied to each one, with one control group at an industry standard 1411 kb. Compression level was the factor under study, and the levels of compression were 128, 64, and 32 kb. Each compression level for each file was graded on a scale of 10-1 (1 being the worst possible listening experience, with 10 being the best) that was developed based on certain changes in the sound of a given track. This rating was the independent variable. These changes took place in the clarity, wetness, distortion, and loss of higher ranges in the compressed files. It was found that there was no significantly noticeable difference at the 128 kb level, but at the lower values, clarity was lost, and the tracks lost significant audible qualities such as high and low ranges. The average ratings for 128, 64, and 32 kb respectively, were 9.333, 6.566, and 2.666. The alternate hypothesis for this experiment was that the decrease in compression rate would have a significant negative effect on the quality of the sound and it did, although statistics show sound quality did not decrease until 128 kb and below. In the future, researchers should ask; what negative qualities of low rate compression do humans notice first?

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The Accuracy Of Hurricane Intensity Forecasts As Compared To A Simple Intensity Model

Oliver Alliss
Loudoun County High School (LCH)

Hurricanes produce considerable damage when they strike a coastline. Accurate hurricane intensity forecasts are needed to save life and property. This project is to assess the accuracy of National Hurricane Center (NHC) hurricane intensity forecasts, and to see how a simple intensity forecast compares to a sophisticated intensity forecast. Intensity is the maximum sustained winds near the center of the storm. The original hypothesis was that there would be no difference between the NHC and the simple intensity model.

Intensity forecast data and the actual intensities from every tropical cyclone of the 2011 Atlantic Hurricane Season was downloaded from the NHC website into an Excel spreadsheet. A simple intensity model was developed to compare to NHC forecasts. The simple intensity model is called a persistence forecast. A persistence forecast is the current intensity of the storm and used as a forecast for the remainder of the advisory. Average error for all forecasts were collected and analyzed. In this experiment, the persistence forecasts served as the independent variable, as it was not changed throughout each advisory. The NHC forecast served as the dependent variable, as it was changed throughout each advisory.

It was determined that the complex NHC forecasts were more accurate, though they had an overall positive bias, meaning they over predicted the storm intensity. The persistence forecasts were less accurate, and had an overall negative bias. An ANOVA test was applied to determine if NHC and the persistence forecasts were significantly different. A p-value of 0.00015 was found. This rejects the Null hypothesis and indicates the NHC forecasts are significantly different from the persistence forecast. Over 1300 trials were used to compute the p-value.

In conclusion, the original hypothesis was not supported. The complex forecasts were more accurate than the persistence forecasts.

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The Effect of Sea Level Rise due to Global Warming on the Southern Tip of Florida.

Jennifer Callen
Tuscarora High School (THS)

Global warming is a rise in the Earth’s temperature; therefore the oceanic temperatures rise as well. As the oceanic temperatures raise, polar ice, ice caps and areas in Greenland and Antarctica, are melting and causing the ocean level to rise. This project specifically looks at the Southern tip of Florida and what can happen if the ice continues to melt. Using ArcGIS you can see how this will affect many people and animal habitats in Florida. As humans put CFC’s (Chlorofluorocarbon) into the atmosphere it destroys our ozone layer. As the ozone layer is gathering holes there is more radiation left to enter our atmosphere, which affect the oceanic temperatures. A small change of only one degree at the equator will result in approximately a twelve degree change at the poles. A melting in this polar ice causes more fresh water to enter our oceans along with more snow fall and rain fall. Warmer water means more evaporation that will cause this to occur. There are more extreme conditions in many other parts of the world extreme droughts and extreme storms. Using the ArcGIS program, data was collected and you will see how the melting of polar ice can cause an area as small as Florida to be put underwater and many habitats put at risk and humans to move to another part of the world. Florida is just a small area of interest there are many other areas that will be affected as well.

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Measuring the Earth’s Core Using Earthquake waves

Edmond Eubanks
Loudoun County High School (LCH)

This project is an experiment to estimate the radius of the Earth’s core using seismic waves. Data is collected from a sample of twelve earthquakes, and observations are made of arrival times of different earthquake wave phases. The Global Earthquake Explorer software tool is used to collect and record the data. Primary S wave arrivals, and non-arrivals, and arc distances at increasingly distant seismic recording stations, are used to estimate the radius of the Earth’s core. Arc distance is the number of degrees along a great circle that the seismic station is away from the epicenter of the earthquake. In the experiment, travel times were recorded from the epicenter of the earthquake. Careful observations are made determining the arc distance of the first S wave non-arrival. Non-arrival of S waves is seen when shadowed by the liquid outer core. This arc distance indicates the beginning of the S wave shadow zone. In the experiment, P and S wave travel times were recorded. Trigonometric calculations use the interpolated mid-distance of the last S wave arrival and the first S wave non-arrival to estimate the core radius of the Earth. A student’s t-test is applied to the core radius estimates from twelve earthquakes to test that the radius of the Earth’s core is not equal to 3488km as noted in the literature. The Student’s t-test was performed using a two-tailed method. A 95 percent Confidence Interval is calculated using the t-statistic estimating the range for the radius of the Earth’s core. The estimate of Earth’s core radius is found to be between 4108.15km and 4138.33km.

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The purpose of the experiment was to make people aware of the poisonous gas that could be seeping into their homes from the layer of rocks below their homes. Radon gas is produced in rocks containing uranium which can cause lung cancer if inhaled too frequently. The independent variable was the areas being tested, and the dependent variable was the amount of radon found at each testing site. The test was conducted using the Pro Lab Radon Test Kit, found from the local Home depot. To test the radon, a test tube was left in the basement of fifteen different houses found in Potomac Station and Red Rock. The test was left for four days and was three feet away from any walls and four feet off the ground. The statistical test used was the t-test. The researcher predicted that household radon levels would be higher overlying igneous rock formations. The hypothesis was supported. It was clear by the end of the experiment that igneous rocks produced a lot of radon. However, they were not the only rock type to do so. The independent variable influenced the dependent variable causing certain radon levels to be higher than others. These findings were very important because it showed that certain neighborhoods have high radon amounts, and if not taken care of, could cause cancer. Further research could be explored in other parts of Leesburg, or even expand to all around Loudoun County. These findings are important to everyone living in a house because they could all be affected by the poisonous gas if not aware. It is important to make everyone aware, and reduce the amount of radon victims, ultimately saving lives.

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The Effect of Geomagnetic Storm Activity on the Accuracy of the GPS Signals

Jordan Horengic
Stone Bridge High School (SBH)

The Geomagnetic storms are induced by coronal mass ejections that are frequent during active phase of the Sun's 11 year cycle (expected to occur 2011-12). They alter the ionosphere and cause errors in GPS satellite signal. WAAS capability on GPS corrects errors caused by ionosphere disturbances, timing, and satellite orbit errors which is being used to account for Geomagnetic storms.

The experiment determined the possibility of correlation between errors in GPS signals (with WAAS on and WAAS off) and geomagnetic storm activity (Kp index) in the ionosphere which may help plan airlines schedule, launching of satellites and spacecrafts.

The readings of the latitude, longitude, and altitude were taken at the same time and location each day (constant) on two GPS units and the control readings (WAAS correction turned on), were subtracted from the experimental (WAAS correction turned off), difference/errors (DV) in the signals were found. The Kp-value was obtained from the space environment website (www.swpc.noaa.gov)

The average difference of Latitude for the control/experimental group is 0.001071429 (variance 2.99E-06), for Longitude for the control/experimental group is 0.00069048 (variance 1.58E-06), for Altitude for the control/experimental group is 0.00. The Pearson’s R number for K-index and difference in Latitude was 0.951 and K-index and difference in Longitude difference is 0.937, both greater than table value 0.304 with 30 degree of freedom (P<0.05) indicating positive relationship (K-index increases, the error in latitude and longitude increases). Storms with larger Kp-index value had a large difference in GPS readings thus supporting the alternative hypothesis.

Further research could determine if Geomagnetic storms affect other telecommunication device (radio or television) signals and see if another type of solar activity effects GPS signals.

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The Earth experiences low interplanetary magnetic field strength during solar minimums because of lower sunspot occurrence during sunspot cycles. As a result, low magnetic field strength causes Earth to be less protected from the solar wind that interacts with its atmosphere and therefore this wind has the potential to alter weather activity. The purpose of this research was to determine the effects of low sunspot occurrence on hurricane and tornado incidences in the United States. Data was collected from May 1996 through June 2010 from archives and analyzed via Pearson correlation statistics to determine if any correlations existed. It was determined that the beginning of the cycle indicated that there was a weak negative correlation between sunspot number and hurricane and tornado occurrence. However, at the end of the cycle an inverse correlation existed between sunspot number and hurricane and tornado occurrences. At the peak at mid-cycle, there was a weak negative correlation for tornado occurrence but positive correlation for hurricanes. Hence sunspot cycles may useful predictors of the hurricane and tornado season.

Further research would entail correlational analysis between sunspot cycles and other variables such as wind patterns across the United States since the formation of hurricanes and tornadoes is influenced by wind speeds. Study of the sun is important because meteorologists can use solar weather to better predict weather patterns on Earth. This ability could save many countries thousands of dollars annually for storm preparation when fewer storms are anticipated and could also save lives.

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Does the Slope of the Land have an Effect on the Likelihood of Sinkholes?

Sean Rogers
Loudoun County High School (LCH)

Sinkholes in Loudoun County pose a significant threat to public safety. The purpose of this project was to determine if the slope of an area affects the number of sinkholes. Using a map made by the Loudoun County Department of Building and Development, the distances from choice mountaintop peaks to sinkhole bases were determined. Also recorded were the elevations of the mountaintops and the sinkholes. Using both, distance and the elevation, the experimenter calculated the slope for each sinkhole from the peaks. The relationship between slope and the presence of sinkholes was determined. The results of the experiment showed that the average distance from a peak to a sinkhole was 566.3 meters (with a 95% confidence interval of 213.8m – 918.8m) and the average slope was .117135 (with a 95% confidence interval of 0.059197 - .17507). The hypothesis was that if slope was measured from the top of multiple peaks to sinkholes, then the slopes would be similar. It was supported by data collected. The slopes from each peak to a sinkhole are similar which suggests that slope increases the likelihood of sinkholes. Further research could explore the water aspect of the experiment. The data collected shows that slope has an effect on the number of sinkholes but what role does the water play in the creation of the sinkhole? That would be one of the recommended research topics if someone was to expand off of this research.

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The Effect of Electromagnetism on Orientation

Rachel Vogler
Heritage High School (HTH)

The purpose of this experiment was to test how different initial angles can affect the amount of time required to orient electromagnets on a satellite to point north. The hypothesis of the experiment was if the initial angle from pointing north was smaller, then the amount of time to rotate ten degrees would be shorter. The independent variable was the satellite’s initial angle from north. The dependent variable was the amount of time required for the satellite to rotate ten degrees. The control of this experiment was the satellite with no current flowing through it. Data was gathered after turning on electric current to one of the three axis and timing how long it takes for the electromagnet to rotate. Angles of 50-90 degrees away from pointing north resulted in rotating ten degrees within four seconds, because of the larger lever arm. Angles of 0-49 degrees away from pointing north ranged from 5-20 seconds to rotate. The conclusion of this experiment was that if the initial angle from pointing north was greater, then the amount of time to rotate ten degrees would be shorter. This did not agree with the hypothesis. Further expansion of this experiment can be conducted by altering the amount of current flowing through the electromagnets and testing how it affects time of rotation.

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### Engineering: Electrical & Mechanical (800)

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Dampening Systems' Effects on Vibrations from Earthquakes

Erik Dulik
Dominion High School (DMH)

The devastation to property, injury and loss of life caused by the vibrations from earthquakes continues to be of great concern to society. The present work is devoted to reducing the amount of vibration a model building experiences during a simulated earthquake through a dampening system controlled by two piezoceramic actuators. An aluminum girder equipped with two activators and a piezoceramic sensor was fastened to the model building. Both the girder and the building were fastened to a shake table that was used to generate the simulated earthquake. A control circuit controlled the actuator in response to the sensor and regulated the amount of dampening. Preliminary tests were used to guide the positioning of the girder and the adjustment of the control circuit for maximum dampening. A series of simulated earthquakes were generated and the acceleration experienced by the building was alternately measured with the dampening system switched off (as a control) and on. Although the piezoceramic actuators used appeared to be very weak and the accelerometer heavier and larger than desired, the results conclusively indicated that the average linear acceleration (taken as an absolute value, since the direction of the acceleration was not significant) experienced by the model building was reduced when the dampening system was on. This study, using a very simple control system provided insight into the use of active systems to create smart buildings that can lessen the vibrations generated from earthquakes.

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Testing the Ability of Materials to Reduce Impact and Absorb Energy in Order to Reduce Concussions in Athletic Headgear

Stephen Gricoski
Dominion High School (DMH)
Academy of Science (AOS)

Nile Roach
Potomac Falls High School (PFH)
Academy of Science (AOS)

Concussions account for over 10% of injuries in football and have been shown to lead to long-term debilitating ailments such as dementia and Alzheimer’s disease. However, the basic design of a football helmet—a rigid polycarbonate shell with a dense foam on the inside—does reduce concussions caused by rotational acceleration. Its rigid design localizes the force of impact. This research suggests a paradigm shift in the design of helmets and hypothesizes that a layer of material placed on the outside of a helmet used in conjunction with internal padding would significantly reduce rotational acceleration due to the ability of the materials to undergo shear strain, which would disperse the force along the outside of the helmet. Moreover, the energy absorption due to shear strain should reduce the acceleration perpendicular to the head. This research chose silicone, butyl, and neoprene rubber as elastomeric external layers due to its ability to undergo shear strain, and polyethylene, neoprene, and minicel foam for internal padding. Through impact testing at three different angles the two best materials from each category were selected to test the effect on a polycarbonate sheet with both internal and external layers. The results supported the hypothesis. The internal padding reduced accelerations significantly in comparison to a Riddell football helmet. The external rubbers further reduced perpendicular accelerations. It was also observed that the tangential accelerations increased causing a spread of the stress along the helmet surface.

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The Relationship of Mechanical Stress on Piezoelectricity Production

Tahn Nguyen
Stone Bridge High School (SBH)

Piezoelectricity is an alternative electricity source where a potential difference is produced in objects with crystalline molecular structures when under stress; piezoelectric objects can harness kinetic energy that dissipates into the environment and convert it into electricity, thus cutting down on waste.

This experiment will determine if the amount of mechanical stress on an object is proportional to the amount of piezoelectric electricity produced by the object, and if the piezoelectric effect is a threshold event.

A system made of a wooden structure and hollow cylinder was designed and constructed. A piezoelectric disk was removed from a fire alarm and placed underneath the cylinder. Two wires were soldered onto the disk and connected to a voltage meter. Mechanical stress was applied, equaling 0.1, 0.2, and 0.3 N (IV), and the highest reading on the voltage meter was recorded (DV). The disk, height, and connection were constant.

The results showed that the amount of piezoelectricity produced had a positive correlation with the amount of stress applied. The average voltage readings were 5.31 V, 9.26 V, and 10.23 V for 0.1 N, 0.2 N and 0.3 N respectively. Results from an Anova and t-Test showed a significant difference (P<0.01) between experimental groups on voltage production. The more stress, the more voltage produced, so the independent variable influenced the dependent variable and the hypothesis was supported.

The experiment also determined that the piezoelectric effect is linear, where an increase in mechanical stress increases piezoelectric output, so it is not a threshold event and the hypothesis was supported.

Further studies observing temperature's effect on piezoelectricity are being conducted, results are pending.

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### The Effect of Friction on Aircraft Tires

Burak Ocak  
Broad Run High School (BRH)

Airplane tires are expensive and don't last long, they're constantly replaced. Currently prior to landing tires on airplanes are stationary, which causes much friction during landing. The idea being presented in this experiment is to have the tires rotating prior to landing; this will improve the duration time of the tire and save cost on tire replacements. To test the landing of the tire a simulated runway is built, a test for both the spinning and non-rotating tire is done. The tires weight is measured before and after the test, then the weights are recorded and compared with the control (tire weight without tests). After being recorded and compared to the control, the non-rotating tires lost a greater amount of weight than the spinning tire. The mean of spinning and non-rotating tires were taken. This showed that the spinning tire lost less weight. A T-test was performed to verify the results. If the wheels on an airplane while landing were rotating about the same speed as the aircraft is moving will cause the tires to last longer than if landing while the tires are not rotating before they touch the ground at landing. The statistics proved the hypothesis. Further research could be used to find if there is a simpler way to find the friction. To gain further knowledge a physics class could be taken to learn about how to find friction.

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The effect of electromagnetic fields on Incandescent, Fluorescent, Halogen and LED bulbs

Seth Turnbull
Loudoun Valley High School (LVH)

The purpose of the experiment was to investigate the possibility of “wireless energy”, to see if electromagnetic fields can induct energy into four different types of light bulbs. To test this, a Tesla coil was used, to create an electromagnetic field by powering two Inductors and creating an oscillating electromagnetic field. The coil would be turned on, and the four bulbs would be equidistant from the coil. If a bulb lighted up, it was noted. When the coil was firing, and the field was generated, fluorescent bulbs did in fact light up with no wires. Tweaks to the Coil are still being made to maximize its efficiency before data is finalized. In the next project, the expansion of the size, power, and output of the coil would greatly affect electronics and other materials, testing how the voltage is increased and current decreased throughout the entire circuit.

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The Effect of an Electromagnetic Field on an Integrated Circuit

Eric Velosky
Stone Bridge High School (SBH)

Many devices from cell phones to electromagnetic pulses produce electromagnetic radiation. Integrated Circuits (ICs) are common in today’s society and are potentially affected by electromagnetic radiation. The purpose of this project was to determine the effect of an electromagnetic field (IV) on an IC circuit (DV). The experimental groups are an IC circuit with and without an electromagnet. The IC circuit was built with a light emitting diode (LED) and the blink rate with and without an electromagnet was recorded. The means of the group with no magnet and with a magnet was 59.53 blinks per minute and 59.45 blinks per minute, respectively. A t-test was performed and showed no significant difference between the groups (P>0.05). The null hypothesis was accepted and the alternative hypothesis was not supported (P>0.05). The electromagnet had no effect on the IC circuit at 1.5 volts, using the North, South, or horse shoe magnet. Further testing is being done with stronger electromagnets. Results are pending. Future research could test different IC circuits or the effect of other types of electromagnetism on IC circuits.

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The Impact of Baseball Bat Certification on the Distance the Baseball is Hit

Samuel Arter
Loudoun Valley High School (LVH)

The purpose of this experiment is to explore the difference between the different baseball bat certifications. This project included four bats of three different certifications. These bats included the Ball Exit Speed Ratio (BESR) certified Easton Typhoon baseball bat, the BESR certified Louisville Slugger Exo-Grid baseball bat, and the Ball Bat Coefficient of Restitution (BBCOR) certified Demarini Vexxum as the independent variables and the Louisville Slugger Wood bat as the Control Group. The dependent variable was the distance the ball traveled after it hit each of the bats. The bats were tested using a pitching machine, which would fire the balls at the bats. After the balls came to a complete stop the distances were measured and recorded. The results of the experiment showed that the BESR certified bats and the wood bat hit the ball further than the BBCOR certified bat. The BESR Typhoon hit the ball an average distance of 9.00 meters, the BESR Exo-grid hit an average distance of 7.13 meters, the Wood bat hit an average distance of 6.53 meters, and the BBCOR certified Vexxum hit an average distance of 5.49 meters. These findings support the experimental hypothesis that the BBOR certified bat would hit the ball a shorter distance than the Wood and BESR certified baseball bats. This experiment could be expanded by using more bats from each of the certifications.

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The Manipulation of Carbon Nanotubules to Enhance and Direct Drug Delivery

Rameen Barish
Dominion High School (DMH)

In the treatment of certain diseases, risks occur in procedures involving radiation therapy and injection in that the drug does not only target the area of the body in need of treatment but can affect the rest of the body as well. This often causes unnecessary harm to other tissues in the patient. The purpose of this research was to attempt a more localized method of drug delivery through the utilization of carbon nanotubes. It was thought that if nanotubes were filled with water and antibiotics (Rocephin), upon laser application, the water would evaporate to steam, expand, and pop the nanotubes thereby releasing the medication.

Petri dishes were cultured with E. coli and divided into the following test groups with the following applications: control (bacteria only), nanotubes only, nanotubes containing medicine, and nanotubes containing medicine which were subjected to laser energy. Plates were incubated and zones of inhibition measured. It was determined that no inhibition existed in any test situation other than those tubes that were opened via laser application and the Rocephin they contained released. Hence, using carbon nanotubes as a novel method of drug delivery merits further consideration.

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The Effect of Temperature of a Solar Panel's Environment on A Solar Panel's Efficiency

Ben Charles
Freedom High School (FHS)

The purpose of this project was to see if the temperature of a solar panel’s environment directly affects its efficiency. The independent variable of the project was the temperature of the solar panel and the dependent variable was the amount of energy that was produced by the solar panel. The control group was the solar panel tested at room temperature. The median for the group at 10 degrees Celsius was 21.6 volts, the group at 30 degrees Celsius was 20.4 volts, and the median for the control group was 21.1 volts. The tests performed on the data were the median test, the standard deviation test, the variance test, the range test, and the t-test. Based on the testing results, the alternative hypothesis was not supported. The independent variable does affect the dependent variable. As the temperature of the solar panel’s environment increased, the amount of energy produced by the solar panel decreased. Further research of this topic could explore whether solar panels have certain temperatures that if they are placed in, stop the solar panels from producing more energy. Since there are different types of solar panels, the other types of solar panels could be tested if they respond the same way as monocrystalline panels at temperature of 10, 20, and 30 degrees Celsius.
The Effect of Guitar Coil Pickups on the Degree of Sound Output

John Clawson
Heritage High School (HTH)

This experiment was performed to test the decibels produced by a guitar if the pickup coils were increased. The results will benefit all guitarists. Everyone wants to be louder on guitar, so this experiment tests an idea of how to do so. The independent variable is the amount of coils on the pickup, while the dependent variable is the amount of decibels produced. The decibels are tested with the original pickup. Then, coils are added to the pickup and the decibels are tested once again. The unaltered pickup produced 94.27 decibels and the altered pickup produced 84.87 decibels. While the means were different, there was no significance in the difference in the data. Even though there was significance in the decibel change, the researcher found that the tone, which is immeasurable, was changed significantly. The tone was muddy and undesirable with too much focus on the low end. The original hypothesis was proven incorrect while the null hypothesis was proven correct. Further research could explore questions arisen from the experiment like what happens when coils on the pickups are decreased among others.

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Optimizing the Seeding Efficiency of Fibroblast Cells on an Electrospun Nanofibrous Scaffold

Tyler Crawford
Stone Bridge High School (SBH)
Academy of Science (AOS)

Shannon Daily
Heritage High School (HTH)
Academy of Science (AOS)

Natural skin grafts are a popular solution for tissue repair; however, they have many limitations. If a large skin graft is needed, there may not be enough skin available on the victim, and skin from a foreign donor may be rejected by the body. An ideal solution would be an artificial graft that can actually support the regeneration of natural skin. The objective of this study was to create nanofibrous meshes that support cell growth. Electrospinning, which creates scaffolds of similar size and porosity to the extracellular matrix of skin, was used to create pure polycaprolactone (PCL) meshes and PCL/chitosan meshes. The concentration of the solution and the voltage used to electrospin the solution were varied to determine the optimal conditions for creating meshes in terms of morphology. SEM images were used to measure structural properties. Biocompatibility properties were observed after placing the mesh in a tissue culture of fibroblast cells. PCL/chitosan meshes resulted in more favorable fiber morphology than pure PCL meshes, including a significant reduction in beading, and were therefore seeded with fibroblast cells. After two days of growth, cells were visible within the mesh, and after five days of growth, cells were attaching and spreading out on the mesh. This shows that an electrospun PCL/chitosan mesh is biocompatible and creates an environment conducive to cell growth, making it a viable candidate for an artificial skin graft.

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The effect of different house structures on destruction after a simulated hurricane

Sara Degooyer
Stone Bridge High School (SBH)

The purpose of this experiment was to determine what structure would sustain the least damage during a hurricane. The three different building designs tested were the regular box house, dome house, topsider house, and the octagonal house. The buildings were placed in a wind tunnel and the destruction of each house was determined by using a scale with 10 different levels of destruction. The median level of destruction for the dome house, octagonal house, topsider house and regular box house were level 2, level 5, level 6, and level 8, respectively.

Separate Chi-square tests compared the median damage done to each type of building. The null hypothesis was rejected. The dome house sustained the least damage. Chi-square tests showed that there was a significant difference between the dome houses and the regular box, topsider, and octagonal houses (P<0.05).

The octagonal design sustained more damage than the dome house, but significantly less than regular box house and top sider (P<0.05) Chi-square test showed no significant difference between the topsider house and the regular box house (P>0.05).

The alternative hypothesis, 'An octagonal structure will sustain less damage during a simulated hurricane than the dome, topsider, or box structures' was not supported because the octagonal house did not withstand the least damage in the simulated hurricane.

The results suggest that the dome house would sustain less damage that the other house designs in an actual hurricane. Further research could explore various-speed winds or varied-directional winds as in a real hurricane.

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The Strength of a Dome versus its Diameter

Charles Freiberg
Loudoun Valley High School (LVH)

The purpose of this experiment was to see if the diameter of a dome has any effect on its strength. The independent variable of this experiment was the diameter of the dome and the dependent variable was the amount of weight it took for the dome to collapse. The control group was a dome with a 38 cm diameter. This experiment was conducted by allowing the dome to be represented by an arch and then attaching a bucket to the arch and slowing increasing the weight by adding sand into the bucket. This was then applied to arches of different lengths while keeping the height constant. After receiving the data from this experiment mean, range, variance, standard deviation, and ANOVA tests were run. The results of the mean tests were that the average weight for the 38 cm dome to collapse was 13.15425 kg, for the 46 cm dome it was 12.077 kg, for the 54 cm dome it was 9.570625 kg, for the 61 cm dome it was 6.2369 kg, and for the 69 cm dome it was 5.4431 kg. The alternative hypothesis which was that, if the diameter of a dome increases then its strength decreases, was supported. After the conclusion of all the statistical analysis, it is clearly shown that as the diameter increases its strength decreases and it is also shown that the IV has a clear influence on the DV based on the results of the ANOVA test which showed the P value as less than .0001. This experiment also raised some interesting questions which could be used for further research including if the test were done on an actual dome instead of an arch as a representation would the results be different?

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How Does the Cheetah Flex-foot Affect the Ability to run?

Austin Gilbert
Loudoun County High School (LCH)

Prosthetic technology has evolved to allow disabled athletes compete against able bodied athletes. The technology has improved so much that people wonder if Oscar Pistorius, an elite prosthetic sprinter, is more able bodied than other elite athletes. In Oscar’s case the IAAF concluded that Pistorius gained an impermissible advantage from the prosthetic Cheetah Flex-Foot and declared him ineligible for able-bodied competitions, including the Olympics. This experiment examines if the Cheetah Flex-Foot gave a mechanical advantage, compared to a biological leg. Therefore, the null hypothesis that the composite limb used by Pistorius confers no mechanical advantage was examined. The alternate hypothesis claims there is a difference between a biological leg and the Flex-foot. The means of the biological leg test is 5.79 (average velocity) and 108.68 (average impulse). A jig was built so force could be applied at an angle perpendicular to the Flex-Foot treating it as a torsion spring; the torque and resultant angle of deflection was measured. The data was consistent with the null hypothesis; the calculated energies were within the range expected if there was no advantage. The ratio of the two regressions, kinetic energy of a biological leg to the potential energy of Pistorius, is 2.54:2.1. The difference between the ratio is 82 percent; other research shows an 82 percent efficiency between the two as well. Therefore, the alternate hypothesis was rejected. In the future, using more athletes to get an average human velocity and corresponding impulses would improve the experiment.

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The Effect of Different Materials on Sound Absorption

Sara Green
Heritage High School (HTH)

Sound absorption affects many areas of the world. Materials that absorb sound are used in churches, concert halls, homes, and everywhere in between. The purpose of this experiment was to discover what material could best absorb sound. Styrofoam, drywall, silicon, sponge, felt, and wool were all tested as the independent variable. Wood was used as the control, due to the fact that the box the sound was ran through was made of wood. The sound reflected off of the materials, measured in decibels, was the dependent variable. In order to test this, an L-Shaped box was built. Sound was ran through this box and data was collected through the end of it via a decibel meter.

This study showed that felt was the most effective at absorbing sound. It allowed only 71.8 dB of sound through the L-Shaped box. Felt was incredibly effective compared to silicon's, the least effective material's, 83.5dB. The control of this experiment (the wood) fell at 81.6dB. The null hypothesis for this experiment stated that all of the materials would absorb the same amount of sound. This was proven incorrect by the ANOVA test as there was a significant difference present between the materials. These results mean that felt could be effectively used in any area that requires sound absorbing materials. Further research should be conducted because there are many more combinations of materials that could effectively absorb sound.

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Microbicidal Effects of Silver and Titanium Dioxide Nanoparticles Embedded in Packaging on Food Preservation

Marwa Hamidi
Dominion High School (DMH)

Each year, millions of cases of illness, hospitalization, and death can be traced to foodborne pathogens. It is in the transportation process of consumer foods in which most cases originate. Illnesses caused by these microbes often arise from poorly designed food packaging. The purpose of this research was to engineer a food packaging paper which would decrease microbial growth in the hopes of preventing diseases and saving lives. Paper was made and embedded with silver, titanium dioxide, and a mixture of both nanoparticles. Pieces of sonicated paper were placed onto Petri dishes inoculated with E. coli and zones of inhibition were measured. Statistical analysis via t-tests determined that the null hypothesis in which no difference would occur in the diameters of the zones of inhibition between silver, titanium dioxide, and a mixture of both nanoparticles was both supported and rejected. Of the three treatments, paper with silver nanoparticles significantly reduced microbial growth. While microbial growth was inhibited via the other two treatments, this was not statistically significant. It was also determined that paper embedded with higher concentrations of silver exhibited greater antimicrobial properties. Further research using greater sonication times to enhance the security of silver ions on the paper may ensure particles do not leach into food. Exploration of photocatalytic properties of metal nanoparticles could provide insight on methods of keeping food safe also. Outbreaks of foodborne illnesses cause major health issues and the safety of the public depends on more sanitary methods.

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The Effect of Materials in Nature on the Insulation of Ice

Hannah Lang
Heritage High School (HTH)

In this experiment, three different materials in nature, soil, grass, and leaves, were tested to see if one of them could keep ice colder after a period of five hours. At the beginning, 15 cups each containing 0.8872 liters of ice represented the control, 15 cups containing 0.8872 liters of ice and 0.8872 liters of soil, 15 cups containing 0.8872 liters of ice and 0.8772 liters of grass, and 15 cups containing 0.8872 liters of ice and 0.8872 liters of leaves were set up in a room with consistent temperature. The temperature of each cup was taken using a CBL in degrees Celsius, and the mean average was calculated for each category. After a period of five hours, the temperature of each cup was again taken and the mean average was again recorded. Then, the original mean average was subtracted from the resulting mean average. The category with the lowest difference was determined to be the resulting variable, in this case, grass, that kept ice the coldest over this period of time. The original hypothesis for this experiment, however, was soil.

With this research, ordinary citizens can take small steps towards becoming more eco-friendly by moving away from insulation made from chemicals and other man-made substances. This could also be used by campers when in an environment where it is necessary to refrigerate food and other items without using an excessive amount of equipment.

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How do Different Soccer Cleat Designs and Different Surfaces Affect Movement?

Elise Levan
Loudoun County High School (LCH)

Testing soccer cleat design on different surface types can aid soccer players in choosing cleats. Choosing a cleat design that supports minimum movement for a surface will increase the performance of the player. By making an apparatus used to control the test, force was measured for two different cleat designs on two different surfaces. Using two different independent variables, cleat design and surface type, to test the dependent variable of kilograms of force determines a more specific result. In addition, lateral and longitudinal forces were tested for each cleat. To attach the cleats to the apparatus in order to do the experiment, the soles of the cleats were detached from the uppers. The results on the grass showed more force used to pull the cleat with a circular stud design. The means for the circular cleat are 14.8 kg vertically and 20.7 kg horizontally, oval cleat, 14.2 kg vertically, 18.6 kg horizontally. On the turf, the cleat with the oval stud design used more force. The means for the oval cleat are 15.5 kg vertically, 18.1 kg horizontally, and for circular cleat 13.6 kg vertically and 16.6 kg horizontally. An ANOVA test showed a P value less than 0.05. These results show soccer players that cleats with circular studs will create maximum performance on grass, while cleats with oval studs will create maximum performance on turf. In Virginia, Bermuda grass is used for most soccer fields. Further research could be done by using different types of natural grass.

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The Effect of Cold Temperatures on the Brittleness/Malleability of Steel

Jack Miller
Heritage High School (HTH)

The purpose of this experiment was to test how greatly decreased temperature affected the brittleness/malleability of steel. The independent variable was the steel temperature and the dependent variable was the degree of deformation of the steel when a force was applied. The degree of deformation was recorded on a scale of 1 to 6, with 1 being bend, 2 being dent, 3 being crack or fracture, 4 being tear, 5 being shatter, and 6 being powder. The steel pieces were impacted with a constant force at progressively lower temperatures, reaching approximately -35 degrees Celsius at the lowest. Dry ice was the primary chilling agent used. The results included higher deformations including cracking and tearing at the middle temperature tested. However, the statistical data in the Chi-Square Test showed that the hypothesis was incorrect, and the null hypothesis was accepted. The null hypothesis stated that if steel is chilled, then the degree of deformation of the steel will not increase. The null hypothesis is basically the conclusion statement of the experiment. However, the test may have yielded different results had lower temperatures been used and if the steel had not been wet (kerosene was used to submerge the dry ice and steel to aid in the chilling process).

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Corrosion on Bridges
Nicholas Nigro
Briar Woods High School (BWH)

The purpose of this project is to find if a protective paint coating on concrete or steel rods will prevent an acid from creating corrosion. The materials included in this experimentation will be steel rods and concrete. There will be two of each material, with one of each material being coated with Rust-Oleum Stops Rust paint. The materials will then sit in two containers for two weeks in sulfuric acid, which will be used to try and corrode the material.

After collecting the final data the sulfuric acid had eaten away at the materials without the Rust-Oleum paint, in addition to eating away the paint that was on one of the concrete cubes. When the sulfuric acid was applied to the material it originally had a pH level of 2, but when taking the material out of the containers the solution in the concrete container had a pH level of 14 and the one in the steel rod container had a pH level of 3. So the acidic solution in the concrete container bonded with the concrete to make a base solution. The calcium carbonate bonded with the sulfuric acid to make calcium carbonate with water.

The hypothesis was proven wrong that the protective paint coating was ineffective against the sulfuric acid on the concrete, but it was effective on the steel rods which prevented any corrosion.

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Morphology of the Nanocrystalline Dye Sensitized Solar Cell

Aishwarya Saikumar
Briar Woods High School (BWH)

Among organic photovoltaic cells Dye-Sensitized Solar Cells (DSSCs) are very promising due to their high efficiency and low-cost technology for converting light energy into electricity. The purpose of this experiment was to identify which anthocyanin solution the DSSC was soaked in would produce the best results, and to see if chenodeoxycholic acid (CDCA) would increase voltage output. The IV in this experiment were the different anthocyanin solutions and the CDCA. The DV was the voltage output, and the control group was the cell without any dye or CDCA. A stained TiO2 coated glass and a graphite coated glass were assembled. Iodine electrolyte was added. A multimeter measured the voltage. The cells with CDCA proved to have better voltage outputs than the cells with no CDCA. The average increase was 19.69%. A T Test was done for statistical results. 5.761E-63 > 1.697, 2.42692E-58 > 1.697, and 1.46009E-33 > 1.697. Results were significant. The alternative hypothesis stated that “If a staining additive is added to the Nanocrystalline Dye Sensitized Solar cell, then the voltage output will increase.” Based on the results and statistical test, this hypothesis was supported. The IVs, anthocyanin solutions and CDCA, greatly influenced the DV. The results showed the blackberry solution to be the most efficient. CDCA increased the voltage output for all the solutions. Other than the three berries used to create the anthocyanin solutions, there may be many other organic substances that can be used to power the dye sensitized solar cell.

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Effect of Nylon Mesh Water Absorption on the Performance of Hard and Soft Lacrosse Mesh

Philip Schroeder
Potomac Falls High School (PFH)

This experiment determined the effect of nylon mesh water absorption on the performance of hard and soft lacrosse mesh. Considering that lacrosse is an outdoor sport that is often played in the rain, knowing which type of mesh will be less affected by rain will allow lacrosse players to make a more informed decision when selecting their mesh type. To perform this experiment, 15 lacrosse heads with hard mesh and 15 with soft mesh were obtained. A lacrosse ball was launched from each dry head which was attached to a catapult. Then, this process was repeated with each wet head. All of the distances were measured in meters and analyzed. The independent variable was the different types of lacrosse mesh (hard or soft), the dependent variable was the throwing performance of the lacrosse mesh, and the control group was the dry hard and dry soft mesh. The results showed that the mean distance the ball traveled when thrown with the soft mesh experienced a 29% reduction when wet. However, the mean distance of the hard mesh experienced only experienced a 2% reduction. The ANOVA test and t-Test were used to analyze the statistics. The hypothesis was if the soft and hard mesh are soaked in water, then the throwing distance of the soft mesh will be affected more than the hard mesh. The results of the statistical tests supported the hypothesis. Further research could evaluate the effect of different temperature and pH level of the water on the nylon mesh.

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The Effect of Barrier Materials on the Range of Wireless Signal

Abhiroop Singh
Heritage High School (HTH)

Why do computers work fast at one location while they are extremely slow at another position? This question is answered in this experiment, while also providing results which will help an average person deploy a router in the most efficient spot by providing the best material for a wireless network to function in. The variables for this research are clay bricks, poplar wood, aluminum sheet metal and the control. The data resulting from this experimentation was measured in meters. Accordingly, the procedures are clear-cut; begin by surrounding a variable, then progress backwards until the signal runs out, and conduct this step for each variable. The ANOVA test was conducted in order to gather the accurate statistics due to the presence of more than two variables. The significant differences in the means of the control, clay bricks, aluminum sheet metal and poplar were 29.025m, 20.02m, 8.953m and 18.956m, respectively. These results will provide the foundation of which material future houses and buildings be constructed of. The alternative hypothesis stated that if clay bricks surrounded the base router, then the range of wireless signal will be highest when compared to aluminum sheet metal, this hypothesis was supported by the data. As shown by the significant differences, there were no relationships present between the independent and dependent variable. Further research could explore the effect of different routers and computers on the range of wireless signal.

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Does Gunpowder Type Affect Bullet Velocity?

Jonathan York

Loudoun County High School (LCH)

This experiment tests if the physical configuration or shape of gunpowder affects bullet velocity. There are 3 configuration types of gunpowder tested: flake, ball and rod. The hypothesis is that flake type powder will produce highest velocities. Independent variable is the type of gunpowder used in a cartridge. Other independent variables such as barrel length and bullet weight were controlled. The dependent variable is velocity produced.

This will help determine what type of gunpowder to use for reloading, such as a fast burning flake powder for lower calibers and pistols, or slow burning rod powder for higher calibers and rifles.

The procedure consisted of priming the correct caliber cases, measuring the correct powder charge, and loading it into the case. Then a bullet was set into the case at an appropriate depth twenty times. The bullets were moved to a safe area where a chronograph was, ten cartridges were loaded into a rifle and fired. After each shot, the velocity of the bullet was recorded. Then the remaining ten rounds were loaded onto a revolver and fired, and after each shot velocity was recorded. This was repeated for twenty additional cartridges, for each of 4 powders.

The hypothesis was supported of the powders tested, flake type powders did produce highest velocities. However, further research identified a gunpowder burn rate chart which lists all gun powders from fastest burn rate to slowest. Muzzle velocity is directly proportional to burn rate. The fastest burning gunpowder producing highest velocity is a ball type powder. It appears that the fastest type of powders are not necessarily flake types, but those that have a very fine consistency, producing a large total surface area, since gunpowder burns on the surface.

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Does the Size of Paper Airplanes affect the Distance in Flight?

Aninder Gill
Park View High School (PVH)

The purpose of this experiment was to find out the size of a paper airplane would affect the distance of flight. This experiment could help airlines determine whether a smaller or larger airplane should be used for longer distances in flight. The independent variables were the sizes of paper airplanes. The dependent variable was the distance of flight traveled. The control group was 21.59 cm x 27.94 cm sized paper. Each paper airplane was individually launched off a three meter tall ladder on a wooden groove at a 45° angle. The mean for the control group was 50.73 cm. The means for trial 17.78 cm x 17.78 cm, 12.7 cm x 12.7 cm, and 7.62 cm x 7.62 cm were 31.96 cm, 19.38 cm, 10.06 cm, respectively. The statistics were calculated with a T-test. The P value of all of the experimental groups compared to the control group was <0.0001. The experimental hypothesis was that if a paper airplane constructed from a sheet of paper smaller than 21.59 cm x 27.94 cm is launched, then it will achieve a greater distance than a larger paper airplane. The hypothesis was rejected. The size of the paper airplanes did affect the distance of flight. Human error would account for the miscalculations in the experiment. Further research could explore if weight of a paper airplane would affect the distance in flight.

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Investigating the Effects Surface Area of Electrodes Has on Output of Microbial Fuel Cells

Nial Hasan
Briar Woods High School (BWH)
Academy of Science (AOS)

Alternative energy sources have been widely investigated, including solar and wind energy; however these sources have economic and technical complications. Microbial fuel cells have led a new pathway in the alternative fuel race in which carbohydrates consumed by microbes are converted to energy. Still, the output presented by these fuel cells is not at practical levels yet. Lovley and Chaudhuri (2003) found that increased surface area of electrodes in microbial fuel cells increases the electrical output with the use of graphite felt electrodes as compared to graphite rod electrodes. A new, one-dimensional form of carbon was discovered in 2001, called graphene. Graphene, a rolled out carbon nanotube, has a much higher surface area to volume ratio than graphite or any other form of carbon. In experimentation, the tested microbial fuel cells with Escherichia coli and graphene fuel cells resulted in almost double the current output when compared to a fuel cell with E. coli and graphite. A statistically significant difference between the current outputs of the two fuel cells exists. The presented fuel cells are also advantageous in that they are very simple to construct. There are numerous ways to fully optimize the tested fuel cell so that one day, on a grand scale, a multitude of microbes can be a major source of energy.

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The Effect of Solar Panel Angle on the Amount of Energy Collected

Ryan Miller
Heritage High School (HTH)

Every year, it is extremely possible that millions of volts of energy are not being collected because of faulty angle position. Because of this reason, the experiment to find what angle solar energy is collected the best was conducted. If energy can be saved due to a mere adjustment in solar panel angle, a lot of difference could be made. In the experiment, the independent variable was the solar angle position, as it could be adjusted. The dependent variable was the amount of energy collected, and the control included the solar panel, the protractor to measure the angle of the solar panel, and the energy source use for the solar panel to collect. The structure to hold the solar panel and the protractor was first constructed. Then a light bulb was hung directly over the solar panel, and then the energy was measured using the voltmeter. The most important finding in this experiment was the data that supported the hypothesis made, that an angle of 90 degrees would collect the most energy. The T test was used for data collection. Because this information was found, someone collecting solar energy as on a solar panel farm might have more productive collection of energy, thus producing a bigger energy output for the world.

In conclusion, the hypothesis that if a solar panel is put at 90 degrees, then it will collect energy the best was indeed supported because it collected the most volts. It is safe to conclude that the best angle to collect energy is at 90 degrees where the energy source always hits the solar panel. The solar panel angle did indeed affect the amount of energy collected. A major source of error was that the energy source was not perfectly aligned with the solar panel.

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The Effect of Solar Cell Curvature on Voltage Output

Shubham Patil
Stone Bridge High School (SBH)

Pollutants from oil and other natural nonrenewable sources can have a long-lasting environmental impact. Solar cells convert the sun’s light, a renewable energy source, to produce electrical energy. Increasing the efficiency of solar cells would increase their cost-effectiveness.

Solar cells were constructed with different curves (independent variable) following the equations $x^2+2x-3$, $.5x^2+2x-3$, $.25x^2+2x-3$ and a semicircular shape. The voltages these produced (dependent variable) were compared to a flat panel. The mean voltages produced were 4.15, 5.04, 5.33, and 5.6 respectively. ANOVA and t-tests showed that the results from the experiment were significant ($P<.05$). The alternative hypothesis that stated that a curved solar cell would produce more volts was supported. The semicircular solar cell produced the most voltage. Light reflects off of all surfaces, including the solar cell. The light reflected off of the curved solar cell and was partially absorbed on the other side. This increased the voltage produced.

In an extension experiment, a solar cell was placed a set distance from a light source, which was then moved at 15 degree intervals to simulate the movement of the sun. The extension showed that at angles from 90 to 0 degrees, the voltage drop was different for the different solar cell shapes. As the angle got smaller the voltage got lower. T-tests showed that the data was significant compared to each other ($P<0.05$). The semicircle solar cell lost the least voltage from 90 to 0 degrees, while the flat solar cell lost almost 3 volts. This was probably because the solar cell reflected light to the other side of the solar cell.

The next step would be to combine shapes of solar panels.

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The Study of the Performance of Quantum Based Solar Cells Incorporating Different Hybrid Layers

Adithya Saikumar
Briar Woods High School (BWH)

Efficient and cost-effective solar photovoltaic (PV) energy conversion is required to harvest the sun’s unlimited power sources. This research is about embedding quantum dots into photovoltaic cells to improve electrical output by enabling the cells to harvest infrared light, and by increasing the lifetime of photoelectrons. As researched last year, Silver (Ag) particles were found to increase the voltage of the solar panel 30%. The next step was to see if any other particle could perform better. Copper (Cu) particles were the next contender. The results of the voltage output for Copper (Cu) saw a 20.4% increase, slightly less than Silver (Ag). An idea then sprung up, based on creating a hybrid mix of both Silver (Ag) and Copper (Cu) particles, with different sizes which will capture different wavelengths to see if the combination could improve voltage output. The hypothesis for this experiment was, if a solar panel surface is coated with hybrid quantum dots (mixture of silver and copper nano-particles) the voltage output will increase. First both nano-particles were layered one on top of the other. The voltage output increased by only 17.4%. However an application of a thorough mixture of both particles on the panel resulted in a 31.6% increase in voltage output. This hybrid mixture proved to be more cost-efficient than pure Silver nano-particles. If it is possible to integrate nano-particle technology with the processes used to mass-produce thin films commercially, it could lead to greater adoption of solar cells as a truly viable alternative energy source.

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Evaluating Methodologies to Prevent Automobile Accidents on Banked Curves: A Cost Benefit Analysis

Robert Wong
Dominion High School (DMH)

Over six million vehicular accidents occur every day. With a large percentage of accidents resulting in fatality, safety is vital. Historically, roads were constructed of dirt, evolving to gravel and finally remodeled asphalt. Despite recent advances in road construction, the biggest obstacle remains the lack of funding to increase safety on non-banked, flat roads.

The purpose of this research was to determine at what coefficients of friction, in conjunction with speed, the application of Super Grip (a road adhesive) would be effective. Engineering Development Corporation’s (EDC) Human-Vehicle-Environment (HVE) was used to generate a computer simulation of four different road types having different radii and slopes upon which a Chevy C-250 and a Ford Taurus traveled. These vehicles were tested at a variety of coefficients of friction upon which speeds were tested at different increments until lateral acceleration exceeded the resistant force resulting in a crash.

It was determined that the application of Super Grip to non-elevated roads would significantly increase safety. For example, application of Super Grip on a flat road having a coefficient of friction of .8 is the equivalent to a super elevated road of .7. Hence when considering the speed limit on a road, the application of Super Grip can be implemented at a coefficient of friction deemed plausible, increasing safety and preventing a vehicle from crashing. Further research would entail simulations encompassing different weather conditions to determine the efficiency of Super Grip use under all environmental conditions.

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Investigating the Potential for Cupriavidus metallidurans and Delftia Acidovorans as Tools for Heavy Metal Bioremediation

Zachary Ballinger
Loudoun County High School (LCH)
Academy of Science (AOS)

A geological study has shown that a bacterial biofilm consisting of Cupriavidus metallidurans and Delftia acidovorans found on Australian gold can precipitate the gold out of the surrounding soil. C. metallidurans has also been shown to express significant heavy metal resistance, and D. acidovorans carries the same metal resistance genes as C. metallidurans. Recent studies have shown that C. metallidurans can precipitate gold and mercury out of solution. A bacterial culture containing both species of bacterium was created. A heavy metal was added to the culture. Concentration of this metal was then analyzed spectrophotometrically using colorimetric reagents. Initial tests showed a significant drop in copper concentration when exposed to the combination of bacteria. Tests on other heavy metals are currently in progress. This project could provide a possible method for bioremediation of waste water contaminated with heavy metals.

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## Investigating Environmental Factors in the Production of Phytoecdysteroids in Spinacia oleracea

Kyra Brower  
Stone Bridge High School (SBH)  
Academy of Science (AOS)  
Frank Song  
Loudoun Valley High School (LVH)  
Academy of Science (AOS)

The hormone 20-Hydroxyecdysone (20-E) found in plants is a phytoecdysteroid structurally similar to the ecdysteroids present in insects that regulate arthropod’s growth and molting cycles. Our previous research has shown that higher concentrations of 20-E has an increased mortality rate in mealworm larvae and therefore has a potential to be used as a naturally derived larvacide. This research is designed to optimize the levels of 20-Hydroxyecdysone produced by spinach plants by manipulating their growing environment. Spinacia oleracea ssp Tyee plants were grown hydroponically, in environments of increased oxygen in the hydroponic system and various concentrations of methyl jasmonate both independently and in conjunction during the development of the plants. Oxygen and methyl jasmonate were used as variables as the spinach plant undergoes hydroxylation, which uses up oxygen, when forming 20-E and uses the chemical methyl jasmonate to signal the production of the hormone. In order to measure the concentration of 20-E in each trial group, the hormone was isolated from the spinach plants using fractional distillation and analyzed using high performance liquid chromatography. Data collected from HPLC testing recorded maximum absorbance at 242 nm and 254 nm, which is an indirect measure of the concentration of the 20-E. Beer’s law was used to calculate the concentration of 20-E present in each spinach sample based on the absorbance units (AU) obtained from HPLC analysis. Preliminary data shows a prima fascia correlation between oxygen and methyl jasmonate levels and 20-E concentrations. Testing continues for further HPLC results and statistical analysis of results.

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The Effect of Different Remediation Techniques for Removal of Nitrates on Water Quality

Sierra Carlson
Stone Bridge High School (SBH)

High concentrations of nitrate in surface and groundwater may result from presence of fertilizers, decaying plants, animal waste and presents health risk. The experiment compared the efficiency of methods for removing nitrates from contaminated water (the maximum contaminant level for nitrate in drinking water set by EPA is 10mg/L or 10ppm) to determine if photosynthetic organism (Synechocystis nigrescens) can aid efficient recovery and recycling of water by reducing the need of fossil fuels or chemical additives, thus reducing expense of water treatment.

0.04 g/L of sodium nitrate (constant) was added to 1000mL of ocean water and the initial nitrate level was recorded as control. 200 mL of nitrate contaminated samples were treated with Synechocystis nigrescens (IV) and 0.5g activated charcoal (IV) and were placed in a photosynthetic rack for 18 days (constants) and then the final nitrate level was measured (DV). The average amount of nitrate left in samples treated with Synechocystis was 5.66 ppm (variance 3.09) while activated charcoal was 35.33 ppm (variance 26.66).

T test showed statistically significant difference (p<0.05) in the amount of nitrate left in the samples with less nitrated in samples treated with Synechocystis nigrescens as compare to activated charcoal at the end of 18 days, thus supporting the alternative hypothesis. Synechocystis nigrescens photosynthesized and absorbed nitrate and reduced to nitrite using an enzyme nitrate reductase, and nitrite is further reduced to ammonium by enzyme nitrite reductase which is incorporated into carbon. Activated charcoal could not absorb nitrates sufficiently.

Future experimentation could explore the effect of environmental conditionals such as availability of phosphate, light intensity, temperature, cell density (inoculums size), and aeration rate on the rate of removal of nitrate.
The Effect of Pollution from Construction on Local Water Sources

Taylor Crew
Heritage High School (HTH)

The purpose of this experiment was to test the effects of construction site pollutants on water sources, and whether or not certain barrier blocking methods could stop them. In the project, the researcher created a model construction site on a hill. They placed pollutants at the top of the hill model, and poured water to simulate rainfall. At the bottom of the model a pollution barrier was placed in front of a reservoir to block the pollutants. The independent variables of the project were the pollution barriers and pollutants tested. The dependent variables were the amount of pollution blocked, and turbidity/pH of the water. The control of the experiment used no pollution barrier to stop pollutants. The results of the experiment showed tarp fencing was best in keeping pH close to neutral 7 (averages of 6.36, 7.02, and 7.) Tarp fencing and solid blocking were equal in blocking nearly 100% of the 30mL of pollutants. Turbidity was unaffected by the barriers. The hypothesis that “solid blocking would be most effective” was proven wrong, because it was not best in all tests. To a degree, the barriers all were successful in blocking pollutant levels in the water reservoir, while the control absorbed all pollution. A major source of error was that the dirt in water affected turbidity tests. Further questions are if there is a single efficient barrier that can block 100% of all pollutants.

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Construction activities such as roadway projects can be significant contributors to sediment loading in streams. The purpose of this research is to determine if and how imperviousness and deforestation have impacted stream health within a 100 feet (standard riparian buffer), 0.25 mile and 0.5 mile buffer around streams tested by Loudoun Watershed Watch in Loudoun County, Virginia. Benthic macroinvertebrate levels were used as indicators of stream health (optimal, good, marginal and submarginal) as created by EPA's RPB. Using ArcGIS, maps were created by intersecting watersheds and stated buffer radii around stream testing sites in order to create a zone that would have directly impacted the benthic macroinvertebrate testing site. This data was plotted over forestation and imperviousness layers, and the percent forest and imperviousness area within the intersected buffer was calculated for each point. This data was graphically analyzed and means and standard errors were generated for each stream health rating to determine the maximum percent imperviousness that had minimal impact on the health of the stream. A prima fascia correlation exists between percent imperviousness and stream health, and statistical analysis continues to determine if this relationship is statistically significant. This data can be used to make recommendations for new construction in Loudoun County as to the maximum percent imperviousness at multiple distances from the stream that will minimize stress on the stream, and can be used to guide environmental planning in this rapidly growing county.
The Effect Of In Situ Soil Remediation On Plant Growth

Jessica Kamienski
Loudoun Valley High School (LVH)

This was an environmental study of which method-physical, chemical, biological-would prove most effective in removing petroleum oil from soil. The independent variables tested were flooding the soil with water (physical), potassium permanganate (chemical), and microbes called Norcardia hydrocarbonoxydans (biological). The dependent variable was the health of pea plants, determined on a scale 1-10, that were re-potted into treated soil. Data was recorded during daily observations and showed that soil washing proved the most effective at removing oil from the soil. The method had a 9.24 average, where the chemical method followed with 8.24, then the control (untreated polluted soil) with 3.94, and lastly the biological method with 2.47. The three methods changed the dependent variable, the plant health. This was proven to not be due to chance by a chi-square test. The expected outcome was the plants would steadily die, saying the methods would have no effect on the soil. The chi-square results disproved this null hypothesis, proving it was not chance alone. The original hypothesis said the microbes would be most effective and this was also disproved by the results. There was an error in microbe measurements which changed the result of that variable. Further research could be experimenting with different types of solutions for soil washing and seeing their effects in removing petroleum oil.

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How Does the Type of Covering on the Water Affect Mosquito Breeding?

Abigail Klansek
Heritage High School (HTH)

Throughout the world, people are affected by Water Dengue Fever, a life-threatening disease which is obtained through a mosquito bite by the Aedes aegypti. The mosquitoes breed in standing water all over the world, especially in places where people cannot afford to dump stationary water every day. If there could be coverings over the water, the mosquitoes would be unable to breed eliminating the cause of the disease. This experiment tested different types of cloth in relation to the number of mosquitoes able to pass through the coverings by collecting natural mosquitoes and testing them in controlled environments. The hypothesis of the experiment was that if a 100% cotton fabric was used, then the mosquitoes will die. The independent variable was the different cloths, while the dependent variable is the number of mosquitoes able to pass through each cloth. The control is uncovered water and the constants are the types of bins used to culture the mosquitoes, the distilled water and the plastic containers to collect the insects. The results were recorded of the number of penetrable mosquitoes for each covering, burlap, cotton, netting, mesh and the control. The calculated means were 0, 0.5, 6.5, 6.86 and 8 mosquitoes respectively. The results supported the cotton, which was the best covering according to the ANOVA test with a p value of p=0, which confirms the hypothesis to be correct. Further research could explore testing other types of coverings, changing the water temperature or adding different chemicals to the water source.

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The Effect of Oil Temperature on Straw's Rate of Oil Absorption

Vincent Mazzola
Potomac Falls High School (PFH)

This experiment was conducted to see if oil temperature had an effect on straw's rate of oil absorption. The goal was to see where straw would be most effective at absorbing oil, thus determining where in the world this method of oil spill abatement would be most effective. The independent variable was the use of varied oil temperatures (0°C, 10°C, and 20°C), and the dependent variable was the rate at which oil was absorbed (grams/hour). The control was the 20°C oil. In the experiment, oil was poured into each bin, straw was added, and after one hour, the new mass of each bin of oil was subtracted from the mass when no straw had been absorbed. It was found that oil temperature had no apparent relationship with straw's rate of oil absorption. The 0°C oil was absorbed at an average rate of 104.03 g/hr, the 10°C oil was absorbed at an average rate of 93.66 g/hr, and the 20°C oil was absorbed at an average rate of 120.83 g/hr. A t-test revealed no discernible relationship. Thus, the hypothesis, "oil will be absorbed faster at warmer temperatures", was not supported. While the hypothesis was not supported, the results suggest that oil may be absorbed best in both extremely warm and extremely cold waters. That is, cold oil has a higher viscosity, allowing it to stick to straw better, and warm oil is absorbed well. This information would be of interest to environmentalists, and those who clean up oil spills.

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Using GIS (Geographic Information System) to Determine Possible Impact Areas of Non-native Shorebirds on Native Shorebird Species

Rachel Meulman
Dominion High School (DMH)

Shorebirds generally exist in small populations and as such are often endangered. Threats occur when limited resources in native shorebird ecosystems are consumed by non-native species during Fall and Spring migrations. Conservation of these birds is important in maintaining populations and biodiversity on Earth.

The purpose of this research was to determine areas along the Atlantic Flyway where there appeared an overlap of native and non-native species of shorebirds. USGS North American Breeding Bird Survey was used to pinpoint geographic locations comprising this migratory path where shorebirds were located. Maps created using ArcGis were used to determine locations of native and non-native shorebirds’ overlap during migration.

Two of the thirty-five species studied were native to the northern part of the flyway, twenty-four were native to the south of the flyway, two were native all along the flyway, and seven were not considered native to either. During Spring migration, fifteen species migrated north, overlapping habitats of two native species and two species migrated south to habitats of twenty-four native species. During Fall migration, no overlap was found in the north but six species migrated south, overlapping habitats of twenty-five native species. This raises conservational concerns and this predictive data could be used to determine the statuses of species in order to preserve their habitats. Expanding the migration path analysis to include South America would be helpful to better assess areas of concern along the entire flyway, in order to maintain resources of native shorebirds when non-natives invade habitats.

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The Effectiveness of the Garden Cress Lepidium sativum as a Phytoremediator for Aqueous Copper and Zinc

Alec Miller
Loudoun Valley High School (LVH)
Academy of Science (AOS)

Aqueous heavy metals from pipes and runoff such as copper and zinc can cause severe tissue damage and illness in organisms. In this experiment, the common garden cress Lepidium sativum was tested to see if it could act as a potential phytoremediator for copper and zinc. If garden cress plants are grown in metal contaminated water, then the metal concentration in the water is hypothesized to decrease due to bioaccumulation of the aqueous metal in the plant tissue. Groups of 25 L. sativum plants were grown hydroponically in controlled environments in a range of metal concentrations. Samples of the water containing the heavy metal were taken over a 14 day time course and the concentration of metal remaining in each individual sample was determined with a spectrophotometric assay. All copper concentrations with growing L. sativum present decreased with time. Therefore, L. sativum is a successful phytoremediator for aqueous copper. Experiments are underway to see if garden cress can also phytoremediate zinc.

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The Effect of Chronic Wasting Disease on White-tailed Deer in Virginia

Troy Mumpower
Loudoun Valley High School (LVH)

The purpose of this experiment was to see if the laws and bans being put into prevent Chronic Wasting Disease (CWD) are working. The hypothesis was if baiting, feeding, and transporting of white-tailed deer in Virginia is banned then the number of white-tailed deer infected with CWD should decrease. White-tailed deer of all ages and both male and female were used for testing. To collect a sample the white-tailed deer would be cut around neck area and lymph node glands would be removed by wildlife biologist and shipped off for testing. In this experiment there was a great difference between the t Stat –3.680011285 and t Critical 2.058963441 to shown the great difference between white-tailed deer infected and not infected with CWD. The hypothesis was supported because the number of white-tailed deer infected with CWD has decreased since the laws and bans. The independent variable had effect on dependent variable by keeping white-tailed deer spread out in the wild by the laws created. A limitation of this project was there was a very short testing window since most samples are taken during various hunting seasons and there is only one test to test for CWD and a back up test would help make more accurate testing. Further research could explore is CWD found more in male or females and could CWD ever be cured and not infected cervid populations across North America?

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Creating a Better Algae

Marshall Rice

Potomac Falls High School (PFH)

This experiment was designed to test the affects of three different nutrients (iron, phosphorus, and nitrogen) on algae growth over a period of time. The hypothesis states that the addition of phosphorus will have the greatest positive affect on algae growth. Three trays were filled with water, and one of the three nutrients in powder form. As a control, one tray was filled with water, but no nutrient was added. Cultures of Ankistrodesmus algae were added to each tray, and all of the trays were placed under a sun lamp. After three days, each of the algae cultures was massed and it was found that on average, the mass of the algae with phosphorus increased from 150 grams to 152 grams, while the mass of the algae with nitrate increased from 150 grams to 154 grams on average, and the mass of the algae with iron increased from 150 grams to 155 grams on average. This contradicts the hypothesis because iron, not phosphorus, had the greatest affect on the growth of algae. Errors in experimentation such as inconsistency in massing, and variations in temperatures could have affected the outcome of the experiment. Using algae to remove carbon dioxide is one method that has some potential, but is currently too expensive to be employed in mass. By increasing the growth rate of algae beyond natural levels, the process of carbon dioxide removal by algae becomes more economically efficient, and therefore more appealing to business executives and investors.

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Helping Coral Reefs One Aquarium at a Time

Victoria Riopelle
Briar Woods High School (BWH)

Utilizing the technique of coral fragmentation, elements of coral reefs can be maintained and flourish in home aquariums. Fragmentation, the method that takes a single coral colony and breaks it up into many smaller distributed pieces may someday help re-grow the world’s damaged reefs. It is hypothesized that if corals are broken to fragments and are implanted into a marine aquarium then they will thrive even after they have grown and are put in another aquarium. The hypothesis was supported by the evidence that was collected. The independent variables of the experiment were the pH of the water, salinity, calcium, carbonate hardness, alkalinity, magnesium, nitrate, and nitrite of the home aquarium. The dependent variable of the experiment were the growth of the corals. The height and width of corals were measured over a 2-3 month period. The average height of Porcillipora damicoris began at 2.025cm and ended at 3cm. The average height of Acropora millipora was 1.55cm and grew to 1.75cm. The average height of Acropora sarmentosa started at 2.275cm and ended at 2.375cm. The average height of Montipora capraconis was 0.85cm and ended at 1.65cm and its average width was 3.1cm and grew to 3.6cm. A question that was raised with this research is if it is possible to do this test on a larger scale and if people with aquariums could donate corals to be used to help restore the dying reefs around the world.

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The Effect of the Different Environments on the Decomposition of Ziploc® sandwich size bags, SunChips® biodegradable bags and brown paper lunch bags

Lindsay Turner
Park View High School (PVH)

The purpose of this experiment was to determine if plastic bags or paper bags decompose in six weeks. This can show which type of bag should be used by consumers, so there can be less trash. The independent variables are the Ziploc® bags, SunChips® bags and brown bags. The dependent variable is the amount the bags will degrade over a six week period. The control group is the Ziploc® bag. This experiment was done by placing three different environments to make a compost pile and different bags in them to see the results. The means for each group were: Ziploc® was 0 cm, SunChips® was 2.977 cm, and brown bags was 0.246 cm. The t-test was used to find if the different bags had an effect in the different environments. The SunChips® bags overall biodegraded the most. The alternative hypothesis was "If Ziploc® sandwich size bags, SunChips® biodegradable bags and brown paper lunch bags are put into mulch, leaves and topsoil then the SunChips® bags will decompose the fastest and most completely in any variety of landfill media conditions." This hypothesis was supported. The statistical analysis showed the p-value for all variables was <0.0001. The independent variable had a huge effect on the dependent variable. The source of error is the experiment should have been during the summer months to increase decomposition. Further research could explore how long each bag takes to biodegrade completely over time and the results are recorded.

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The Effectiveness of Bioremediation on an Oil Spill

Lana Vaillancourt
Loudoun Valley High School (LVH)

The purpose of this study was to determine if the use of natural products could combat man-made problems. In this experiment, powder nitrogen was added to beakers of Gulf of Mexico, pond, and tap water that contained oil to simulate an oil spill. They were then monitored to see if the oil level lowered. The independent variable was the nitrogen added to the beakers. The beakers without the nitrogen were used as the control and the dependent variable was the change in oil level. The results found that the nitrogen did impact the oil level and that bioremediation is an effective way to decompose oil naturally. The water types without nitrogen had a consistent mean of 5, meaning that the oil level did not change at all in the controls. The Gulf of Mexico water had a mean of 3.81 while the pond had a 3.93 and tap had a 4.75. This means that the Gulf of Mexico had the largest difference in oil level and had the lowest amount after the ten day testing period. The experimental hypothesis, that the water samples with nitrogen will hasten the growth of the natural algae to decompose the oil leaving a lower level of oil than started with, was supported. Further research could explore the impact of algae blooms on the ecosystem. Although changes in the animals would be seen from the effects of the actual oil spill, the changes in population from the algae bloom could also impact the food chain.

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Effect of Oil Dispersants on the Lifespan of Daphnia Magna.

Kamran Waterman
Freedom High School (FHS)

To cleanup coastal areas after the 2010 Gulf of Mexico oil spill, British Petroleum used oil dispersants, which sparked interest in the effects of dispersants on marine life. BP used Corexit 9500, produced by Nalco, to break down the oil into small droplets. Unfortunately, these droplets fell to the gulf floor and were ingested by marine life, many of which then died. Environmental scientists believe that Corexit 9500 was harmful, yet BP insists the chemical is safe. Both Nalco and BP refused to provide samples of Corexit 9500 for this experiment. Nalco insisted that Dawn dishwashing soap has the same effect as Corexit 9500. Therefore this experiment was conducted to test the effects of Dawn on the lifespan of Daphnia magna, a clear microscopic organism. The independent variable was the amount of exposure to Dawn soap (5mL, 10mL, 15mL), the dependent variable was the lifespan of Daphnia magna, and the control group was Daphnia magna exposed to 250mL of distilled water. Data showed that most Daphnia magna were dead at 15mL of exposure and there was a steady decrease in heartbeats-per-minute as exposure to Dawn increased.

It is possible to conclude that since Dawn had a negative effect on Daphnia magna, that certainly Corexit 9500 would be harmful to marine life. However, questions still remain regarding the toxicity of actual Corexit 9500 vs. Dawn soap, and its impact on Daphnia magna. For future experiments it would be essential to obtain Corexit 9500 to determine its exact effects on marine life.

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Phytoremediation: Absorption of Reclaimed Motor Oil using Glycine max (soybean), Lolium multiflorum (ryegrass), Lycopersicon esculentum (tomato), Raphanus sativus (radish)

Nicole Whalley
Loudoun County High School (LCH)

Phytoremediation is a type of bioremediation that uses plants to absorb oil from oil spills. It is a popular, cheap, easy way to remove oil and this process does not give off any bi-products. To help identify which plant species can remove an adequate amount of oil, radishes (Raphanus sativus), ryegrass (Lolium multiflorum), soybean (Glycine max) and tomato (Lycopersicon esculentum) plants were planted for three weeks in 2.5 mL of reclaimed motor oil to test how much oil they could absorb. The first procedure used was the centrifuge that tested the amount of oil absorbed by spinning fifteen plants of each species after being planted. The second procedure used was the dry mass procedure that tested the amount of oil remaining in the dried soil in which fifteen plants of each species were present. In both procedures the oil was weighed in grams. The soybeans absorbed the most oil in the centrifuge procedure because all fifteen soybean plants contained 0.215 grams of oil. In the dry mass procedure, the ryegrass absorbed the most oil because all two hundred and forty ryegrass plants contained 81.364 grams of oil. From this experiment, it is suggested that soybean and radish plants can absorb an adequate amount of oil. In the future, this experiment could be modified by using less than 2.5 mL of oil, planting species outdoors during spring, and using the same procedure to find the amount of oil absorbed for all 30 trials.

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The Effect of Sodium on Pleurotus Ostreatus’ Ability to Clean Up Motor Oil

Brennan Wright
Heritage High School (HTH)

This experiment was inspired by the horrible Gulf oil spill, which will have a lasting effect on the entire ocean ecosystem and will have repercussions for years to come. This experiment used mushrooms to break down some of the harmful chemicals found in motor oil in water with different levels of salt. The independent variable was the levels of salt in the water, ranging from no salt, to 3.5% salt levels. The dependent variable was the amount of oil left over after four weeks. According to the ANOVA test, the amount of salt had no effect on the amount of motor oil left over. But this could be considered a good thing, seeing as this method could be used in many situations where motor has been spilled. If these results can be reproduced, they can be considered a stepping stone for the future of mycological remediation. But there are variables that could not be tested in this experiment. Before this experiment can be put into action, weather, heat, wave-action, and other variables that could not be tested in this experiment must be tried first. Further research could explore the best way to introduce the spores to the oil, real-life variables, as mentioned above, or if there are any other mushrooms that have the same ability to clean up this motor oil.

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## Environmental Sciences (1200)

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Enhancing Frustule Development in Diatoms to Remediate Aquatic Carbon Dioxide

Saieh Bijani
Dominion High School (DMH)

Diatoms are brown-green, photosynthetic algae and are primary components of phytoplankton, an important food source for aquatic organisms. They are confined by cell walls known as frustules which are composed of silica. Diatoms serve as population tools for monitoring environmental quality because they absorb dissolved carbon dioxide produced by society’s use of fossil fuels.

The purpose of this research was to determine whether frustule development could be enhanced via the addition of silica to the environment. It was hypothesized that if frustule growth could be increased, the weight of the diatoms would cause them to sink hence dragging dissolved carbon dioxide, a major cause of global warming, to the bottom for sequestration. Frustule growth was observed after silica was added to diatom cultures which were supplied with phosphate and nitrogen for growth.

Statistical analysis via t-test determined that the growth of frustules in both Synedra sp. and Navicula sp. was not significant. In fact, frustule development decreased with the addition of phosphates and nitrogen. This was alarming, given the fact that diatoms sit at the bottom of the food chain and are major food sources for many marine animals. The negative effects of nitrogen and phosphates may actually be quite common given that these are major causes of water pollution. Further research would entail increasing silica concentration to counteract negative effects of phosphates and nitrogen. If the balance of dissolved nutrients plays a vital role in ecological equilibrium, negative impacts of other pollutants should be investigated.

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The Effect of Development on Water Quality in the Potomac River

Christopher Coggins
Broad Run High School (BRH)

The purpose of this experiment was to determine whether or not the amount of development in certain areas in proximity to local surface waters effected the water quality in that area. This project was conducted by taking samples of water from Point of Rocks and East Potomac Park, the independent variable, and testing them to see the levels of nitrates, ammonia, pH, and oxygen in them, the dependant variable. These tests were conducted with a freshwater test kit. The means for the values taken from Point of Rocks are, pH - 7.34, nitrates - 0 ppm, ammonia - 0.3 ppm, oxygen - 8 ppm. The values from East Potomac Park are, pH - 7.56, nitrates - 0.1 ppm, ammonia - 0.35 ppm, oxygen - 6.8 ppm. When t-test was taken, the results for pH were P<0.01. When testing nitrates the results were P<0.05. Ammonia was the same, with P<0.05. Finally Oxygen was P<0.01. These results conclude that the hypothesis, If water is taken from a more developed area, then it will contain higher levels of pH, nitrates, ammonia and oxygen, is rejected since East Potomac Park (developed area) had lower levels of Oxygen. The IV had an effect on the DV, as the water samples produced different results. One major source of error was the time slot given, as the water was tested daily and only five times. One question that could be asked is, if more time for research was given, would the results have differed?

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The Effects of Sub-lethal Exposure to Carbon Dioxide on Procambarus clarkii (crayfish) Foraging Ability

Daniel Day
Dominion High School (DMH)

As fossil fuels are increasingly used as energy sources, they also cause higher levels of carbon dioxide in the atmosphere. This gas is commonly absorbed by all bodies of water on Earth hence causing a rise in acidity levels. Increased acidity in aquatic environments raises the risk of detrimentally affecting important organismal behaviors such as the ability to forage for food.

The purpose of this research was to determine whether the ability to successfully forage for food was affected in crayfish. It was hypothesized that, if exposed to acidic conditions, deterioration of food finding structures such as antennae and antennules in crayfish would be increased. Thirty-two crayfish were separated into four groups of eight crayfish. Each group was subjected to differing pH levels. Meat was then added to their tanks and the time it took for the crayfish to find the food was noted over a six week period. It was determined that the average time it took crayfish to find food and start eating increased as acidity levels increased. Thus the hypothesis that acidic water would affect crayfish foraging was supported.

Further research would entail an exploration of this phenomenon on aquatic species which occur lower on the food chain. This is important worldwide because water acidification may have a major impact on marine ecosystems that could be felt for hundreds of years. The demise of these organisms on the lower end of the food chain could potentially cause the crash of some aquatic ecosystems.

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How do Green Roofs Affect Water Absorption Compared to Shingle Roofs?

Rebecca Doody
Broad Run High School (BRH)

The purpose of this experiment was to show the amount of runoff given off by both green and shingle roofs, showing the great amount of pollution that runs into the nearby waters. This project's independent variable was the types of roofs, and dependent variable was the amount of water absorbed. The experiment consisted of building the two different types of roofs. Once the roofs were constructed one liter of water was poured on both types of roofs reading the runoff results after every five minutes for a total of an hour. The mean amount of water runoff for the green roofs was 585 mL and the shingle roofs was 928.5 mL. The t test had a result of 0.001. If the amount of water runoff on a green and shingle roof is tested then the green roof is going to have less runoff than that of the shingle roof. The experimental hypothesis was supported, due to the statistical t test with results that were significantly different with a p value less than 0.05. The types of roofs did influence the amount of water absorbed. One major source of error was that the trials on the green roof were interrupted by rainfall, causing results to be skewed. It is possible they did not absorb as much water as they could have, with the extra rainwater. Further research could explore the process of green roofs absorbing water after a lot of rainfall and how much water they can absorb in different seasons.

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Investigation of Lead (Pb) Isotopes in Quercus spp. to Determine the Effects of Air Transportation on Pollutant Present

Samuel Kane
Dominion High School (DMH)
Academy of Science (AOS)

An internal comparison of active oak trees (Quercus l.) was conducted around airports to determine the effects of leaded gasoline on lead levels in oak trees. Tree samples were taken from Leesburg Executive Airport in Leesburg, Virginia and from Dulles International Airport in Dulles, Virginia to compare both large and small aircraft LTO cycle effects. Samples were taken as close to both ends of the main runway as possible and another in the middle of the runway using an increment borer. Samples were then digested into liquid until clear using a Digestdahl Digestion apparatus. These liquids were then subjected to reagent testing and spectrophotometric analysis to determine the percentage of lead in solution. Preliminary tests show an elevated presence of lead compared to a negative control, while actual numerical lead concentrations are currently being calculated. This study has greater implications as lead has detrimental effects on tree health, resulting in a return of free lead to the soil upon death, where it can enter the water table and spread beyond isolated sources.

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The Effect of Environment Friendly Household Cleaners versus Standard Cleaners on Plants

Katherine Melhuish
Broad Run High School (BRH)

The purpose of this experiment was to determine the effect of household cleaners, while being compared to new environment friendly chemicals, on plants. The study of the effects came from events such as Hurricane Katrina, and health problems that were believed to be the result of daily household cleaners. Effects such as cancer, birth defects, and reproductive errors, were recorded. But there was rarely any information about the eco-friendly chemicals found. To determine what both types of cleaners do to effect plants would be significant because then results would show which cleaner was more healthy, if any. This was possible for the control was regular water, which is completely healthy. The environment friendly cleaners were expected to have a higher growth rate when comparing the height of bean plants. This was true, the plants given a solution of 1 part environment healthy cleaner and 9 parts water grew about 18% higher than the plants given the standard cleaner solution. Although the plants given the eco-friendly solution grew higher, the other set of plants given the standard cleaner solution became a darker green, and represented more leaves. Expanding this project and determining why that happened is something that should be determined someway, because the standard chemicals obviously showed some manipulation among those plants. The growth of the plants proved the hypothesis supportive; the environment friendly solution given to the plants grew higher than the plants given the standard cleaners. But, as said, further investigation should be held due to the odd manipulation by the plants given the standard household cleaner solution.

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The Comparison of Amount of CO2 Produced by Bioplastics and Fossil Fuel Derived Plastics During Degradation

Paige Neiderer
Stone Bridge High School (SBH)

Biodegradable plastics can either be “bioplastics” made from renewable sources, such as starch or “fossil fuel derived plastic”, and are decomposed by microorganisms in natural environments. When fossil fuels are used, CO2 is released into the atmosphere faster than natural processes can take it away. Bioplastics may reduce consumption of non renewable energy and carbon dioxide emission.

CO2 produced by bioplastics and fossil fuel derived plastics during degradation was compared to determine which biodegradable plastic releases more CO2 during degradation and is more damaging to the environment.

Biodegradable plastics (IV) and Fossil Fuel plastics (IV) pieces were placed in sealed aluminum cans with Drano (constant), to speed up the degradation process for 10 days and then the amount of CO2 produced (DV) was measured in ppm, using a CO2 probe labquest.

The T-test and ANOVA did not show statistically significant difference (p>0.05) in CO2 produced by bioplastics and fossil fuel derived plastics, thus refuting alternative hypothesis. Bioplastics produced more CO2 (17571 ppm with the variance of 8.4E+08) than the fossil fuel derived plastics produced (12730 ppm with the variance of 4E+07).

No significant difference may be due to the fact that the experiment compared the amount of CO2 produced during degradation and did not consider the amount of CO2 taken up by biological material during growth and did not calculate the total carbon dioxide emissions. In order to evaluate the overall impact on the environment, the factors such as depletion of natural resources during production, use, disposal, and toxicity needs to be analyzed.

Further studies could test the duration of biodegradation, the factors that can speed up degradation in natural environment (such as oxygen, UV light, moisture). The effect of byproducts of degradations can be tested for toxicity.

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### Ants Impact on pH, Nitrogen, and Phosphorous Levels of Soil

Henry Rihn  
Loudoun County High School (LCH)

This experiment was devised to test the affect of ants on the pH, Nitrogen, and Phosphorous levels of different soils. Data is collected from four different ant farms, each filled with different soil types to determine if the pH, Nitrogen, and Phosphorous levels are effected by the ants differently under different conditions. To test the pH, Nitrogen, and Phosphorous levels of each soil test strips were used. Date from the four soil types was gathered weekly and after four weeks the changes were prevalent in each test group. The belief that Nitrogen and Phosphorous levels would be raised, as is likely do to ants role as decomposers and aerators in their environments, was proven correct as expected, but what one might not expect is that the soil also showed a trend towards neutrality when the pH was tested over this four week period. A statistical T-test was used to check these results, a t-test for each group showed that the “p-value”, or likelihood of results being from chance, was below 5%, meaning that these are unlikely to be from chance and that the ants' ability to change their environment has merit. These results show the benefits of ants to an environment in their ability to enrich the soil with minerals required for life as well as their interesting ability to neutralize pH of soils.

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The Relationship Between Stream Location and Macroinvertebrate Health

Lauren Salman
Stone Bridge High School (SBH)

Using benthic macroinvertebrate assessments, ecologists can determine the water quality of a stream, river, or other body of water. The healthiest streams have diverse populations of pollution-intolerant species. The purpose of this experiment was to determine the areas in which the healthiest bodies of water are found, among residential areas, urban areas, and non-agrarian rural areas.

Two streams in each location category (IV) were sampled for benthic macroinvertebrates (DV). The samples were then sorted and individuals identified to Order. The taxa richness (number of different taxa) was calculated, along with Hilsenhoff’s Biotic Index (HBI) to determine pollution tolerance of the overall community, and Simpson’s Index of Diversity (SDI) to measure the diversity.

Non-agrarian rural sites had the highest average taxa richness followed by residential, and then urban. ANOVA returned P < 0.05. The T-test between the taxa richness of the non-agrarian rural sites and urban sites showed statistically significant difference thus supporting the alternative hypothesis. Many different natural factors could have influenced the macroinvertebrate population, such as weather or differing currents in each stream.

The non-agrarian rural sites also had the best HBI and SDI ratings, again followed by residential and then urban showing that rural areas had the statistically larger population of pollutant-intolerant benthic macroinvertebrate taxa, as compared to residential or urban areas.

Future researchers should keep in mind when evaluating stream health that location does matter, as well as pollution type. Pollution differs significantly from non-agrarian rural to urban areas, and overall diversity and tolerance of the benthic macroinvertebrate population may suffer because of it. Future research could also take into consideration the structure of the stream, such as the pattern of riffles and pools and the amount of habitat available for benthic macroinvertebrates.

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<td>Riley Sanborn</td>
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<td>Potomac Falls High School (PFH)</td>
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This project was designed to show the dissolved oxygen levels in the Potomac River as the river water travels down river. The independent variable in this project was how far from the origin of the river the water sample was taken, the dependent variable was the amount of dissolved oxygen that the sample contained. The procedure for this project was to take samples from the Potomac River every 40 kilometers, making sure to keep any atmospheric oxygen out of the bottle.

The hypothesis was that as the water traveled farther from the source of the river, the dissolved oxygen content of that sample would decrease. What was found after this project was completed was that as water travels farther from the source of the river, there was less dissolved oxygen in the water. One exception was the sample taken from Great Falls, VA. Since there was a finding that contradicted the hypothesis, the hypothesis was rejected.

Further research could be done to find out if the dissolved oxygen content varies at different times of the year. Also, one could research how dissolved oxygen contents could be raised, or if supplements added to the water have any affect.

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The Desalination of Soil

Corley Simons
Loudoun Valley High School (LVH)

The purpose the experiment was to discover how salt water floods, representing a tsunami, affect agriculture (grass in this case) and the processes that have the most success removing the salt from the soil. The independent variables were the different methods of desalination: gypsum, fresh water, hydrolyzed polymaleic anhydride, and mulch. The control group was grass that received salt water, but no method of desalination. The dependent variable was the salinity recorded over time. The pods of grass were given 26 days to germinate. After this, they were flooded with 20mL of salt water and then the processes were tested on separate pods. The gypsum had the most success in desalinizing the soil with a mean salinity of 10.01mS/cm (milli-Siemens per centimeter). The mulch had the least effect with a mean salinity of 13.43mS/cm. Polymaleic acid had a mean salinity of 11.55mS/cm and fresh water had a mean of 10.42mS/cm. The ANOVA test did not support the null hypothesis. The alternative hypothesis was not supported because the mean of polymaleic acid was not the lowest. All desalination methods tested made some impact based on the drop of salinity level over time. Pod B in the polymaleic group did not receive exactly 10mL due to a spill. Pod C in the fresh water group container was broken. Further research could explore one specific method at different amounts. Grass seed could then be regrown after desalination to show soil improvement.

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The Effect of Wolbachia on the Apis mellifera Population

Mohini Singh
Briar Woods High School (BWH)

Ninety percent of the crops worldwide are dependent on pollinators; one of the most abundant pollinators are the honeybees. The honeybee population is declining at a rate of twenty to thirty percent a year. This experiment was done to see if Wolbachia is a factor that plays a part in the declining population. Wolbachia is a symbiotic bacteria that grows inside its host’s reproductive tissues. In some insects in which Wolbachia has been sighted, it weakens offspring from generation to generation, kills the male embryos, and alters the sex ratio. Local bee keepers provided bees to be tested for Wolbachia infections. DNA extracted from the bees was amplified using PCR and then separated by fragment size using gel electrophoresis. The PCR fragment size was compared to fragments from infected nasonia wasps. It was determined that some bees from each hive tested positive for Wolbachia. Current data shows that thirty two percent of the bees tested were positive. Additional bees are being tested. One of the hives in the study collapsed after bees were collected, this hive showed positive results for Wolbachia and fewer drone cells were observed. Based the data collected it can be concluded that Wolbachia can be a contributing factor for the decline in honeybee population and a possible factor in hive collapse. Further research will include more hives from different locations in Loudoun County, Virginia.

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The Effect of Rain Patterns on the Dispersal of Surface Oil in the Deepwater Horizon Oil Spill.

Eric Weismiller
Freedom High School (FHS)

This experiment examined the effects of rain on the dispersion of surface oil over short periods of time. Oil dispersion has been researched various times prior to this experiment, but that work mainly focused on dispersion over long periods of time. The purpose of this experiment is to understand if surface oil from the Deepwater Horizon Oil Spill (DHOS) was dispersed by rain. Pairs of satellite radar images from stormy days were compared with pairs from clear days. Each image pair consisted of a before image and an after image of the same area separated by a 12 hour period. The hypothesis was that rain would cause more oil dispersion, so that there would be more change on the stormy days than the clear days. The images were careful selected for overlap of the oil spill area. A computer program called “Genie Pro” was used to analyze how much surface oil appeared in each image. This research could have an impact if scientists knew whether or not rain dispersed the oil because it would allow them to prepare for the dispersion and make some proactive choices to keep the oil in one place. The radar images were taken by COSMO-SkyMed and RADARSAT satellites, provided by eGEOS and MacDonald Dettweiler Associates, respectively.

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### Mathematical Sciences (1300)

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Using SPSS 20 to Determine the Correlation Between the Decline in Gross Output of the Airline Industry and the Decline of other Macroeconomic Sectors Following September 11, 2001.

Alexander Bala
Dominion High School (DMH)

The decline of economic growth in the airline sector after September 11, 2001 has been known to have various negative effects on the entire United States economy in the years following the tragedy. The supposition of the interdependency between inputs and outputs of sectors is that a decline in the gross output of one sector would have an effect on multiple macroeconomic sectors.

The purpose of this research was to determine how strongly the decline in total gross output of the airline industry correlated with the decline of thirteen other macroeconomic sectors such as agriculture, wholesale, manufacturing, etc. Data for total gross output was taken from the United States Bureau of Economic Analysis from 1998-2003 and subjected to bivariate correlation analysis using the IBM SPSS 20 statistical package. Residual plots and significance values were assigned to each sector in accordance to the airline industry. The sectors strongly correlated with the economic decline of the airline industry after 9/11 were manufacturing and agriculture, which experienced significant decline. Least correlated sectors were utilities and wholesale which appeared to be minimally affected the decline of the airline industry. P-values were deemed significant if they were below 0.05, with plots having a significant positive slope.

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How the Wind Tunnel Effect in New Yankee Stadium Affects Number of Homeruns

Kyle Cicalese
Loudoun County High School (LCH)

Researchers have suggested a wind tunnel effect as the cause to the unusual number of homeruns hit in New Yankee Stadium in its first home series in April of 2009. Due to short tiers at the top of the stadium and a steep seat angle, westerly winds of 16.1 km/h are said to “activate” this wind tunnel effect that would cause a significantly high number of homeruns than in any other National League East or American League East stadium. A total of 9 different stadiums experienced homeruns affected by wind going either towards or away from the batter. This investigation covered a period from July 14th to September 27th, 2011. The total number of homeruns hit in each stadium after 30 trials was determined. Regression tests with wind strength being compared to homeruns hit in the stadium were run. The P-values for each group were: Citizens Bank Park, 0.602; Camden Yards 0.456; Citi Field, 0.814; Fenway Park, 0.738; Nationals Park, 0.209; Rogers Centre 0.776; Sun Life Stadium, 0.127; Turner Field, 0.99; and New Yankee Stadium 0.685, respectively. The null hypothesis of wind not affecting homeruns was supported. The data indicates that no wind tunnel effect is present in any of the groups however if more data were collected it may suggest otherwise. Further research may require data collection for an entire season to possibly change the results.

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Solving 2D Shallow Water Equations and Discrete Erosion Equations for an Instantaneous Dam-break model

Samuel Dooman
Loudoun County High School (LCH) Academy of Science (AOS)

Predicting dam break flows is one of the most active subsets of hydraulic engineering. The prevailing method for dam-break modeling involves numerically solving the Saint Venant equations which describe incompressible fluid motion in two dimensions using the Finite Volume Method. In recent years, much of the research in this field has been focused on testing the modification of the shallow water equations to include factors such as specific beds and friction. Many models are able to import Digital Elevations for flood plain topography to predict flows more accurately at a specific dam site. However, previous models do not take into account that the topography of the flood plain will be morphed by the dam-break flows. This paper presents a model which uses an upwind Finite Volume scheme to solve modified Saint Venant equations which include equations to describe the erosion of the topography around the dam site. To date, a simplified 1D model has been developed using the Wolfram Mathematica v.8 software to determine its capabilities for dam-break modeling.

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The Relationship Between Mathematical Card Tricks and the Mathematical Operations

Andrew Lee
Briar Woods High School (BWH)

A mathematician can be a useful card magician. The purpose of this experiment was to observe the mathematical operations involved in different card tricks and see if any of them are used in more than one trick. The hypothesis was that if each card trick contained a mathematical operation, then some of them can be reused. The mathematical card tricks are the independent variables while the mathematical operations are the dependent variables. The control group is the card trick called The Four Kingdoms. The procedures include performing the card tricks and figuring out the mathematical operations behind them. Once they are figured out, they will be checked if more than one card trick uses the same operations.

The most important finding is that none of the ten card tricks shared more than two mathematical operations. Some did not share at all. The chi square test was used which accepted the null hypothesis. The frequency distribution of the card tricks and the mathematical operations is not significantly different from the frequency distribution predicted as seen in Figure2. The null hypotheses was accepted ($X^2=4.5 <16.919$ at df=9, Table 10.6). Because the chi square test rejected the research hypothesis the, IV did not influence the DV. There were no major sources of error. Questions for further research can be; is there a more advanced mathematical operation that can be used?

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The Efficacy of Using a Financial Model to Support the Efficient Market Hypothesis

Kevin Mathews
Dominion High School (DMH)

Many investors transfer funds via the use of the stock market daily. Although some investors experience high rates of return, the tendency of the market to grow seems to be in question. Whether the market accurately reflects stock prices or whether they are affected by behavioral economics is of debate. The purpose of this research was to determine whether the market mirrors the Efficient Market Hypothesis, that information is equal and price prediction is impossible or the Adaptive Market Hypothesis which proposes that behavioral economics affects the market and that the market is not efficient. Originally, the Random Walk Theory, that the market moves randomly and is unpredictable, was tested using Fathom. Secondly, whether prices in the Dow Jones Industrial Average could be predicted was determined, refuting the Efficient Market Hypothesis. This was accomplished by attempting to re-express historical data from the Dow Jones Industrial Average since 1952. Statistical analysis was conducted of the Dow Jones Industrial Average manipulation via linear regression which determined that there was no effective way of predicting the next day’s stock averages. The Random Walk theory was supported using Fathom. The price of generic stock waivered and was unpredictable. Hence, this lent support to the Efficient Market Hypothesis. Further research that quantifies behavioral economic factors affecting the stock market such as media reports on economic downturns would be needed to fully determine whether the Adaptive Market theory holds true. Worldwide, this would help investors create a stronger investing strategy thus helping the global economy.

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The Effect of OPS with RISP on OPS in L/C Situations

Kyle Sargent
Woodgrove High School (WHS)

The purpose of the experiment was to study the correlation between two high pressure situations in baseball, which are in late/close situations (L/C), and when there are runners in scoring position (RISP). The top 200 players in at bats for 2011 were selected for examination. A player’s OPS in a high pressure situation was the independent variable and the dependent variable was a player’s OPS in a high pressure situation minus his overall OPS. The control group was a player who always had a dependent variable of zero. Now a clutch player for a given high pressure situation has a large, positive difference for the dependent variable, while a player who considered a choker has large, negative difference, and all the players with little difference were neutral. For instance, Justin Turner of the Mets was most clutch with RISP who had an OPS with RISP that was .290 higher than his overall OPS. The hypothesis stated that a player would be clutch in both high pressure situations, was not supported. It was found that the two high pressure situations have no correlation at all, that nearly an equal number of players who performed the opposite in the two situations as there were who performed the same in the two situations. Future research could explore previous years and see if the results are similar. This study helps prove the theory that clutch players don’t exist, only good players.

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Modeling Wolbachia as an Effective Agent to Reduce the Transmission of Lyme Disease

Jacob Savos
Dominion High School (DMH)
Academy of Science (AOS)

Inadequate mathematical models, coupled with problems in diagnosis and treatment, have been found to be major obstacles in combating Lyme disease, even as this disease is making headlines and starting to be recognized as a major epidemiological problem in the US. In Northern Virginia and Loudoun County in particular, the problem has caught the attention of public health as well as elected officials. My work in this area introduces a unique approach to attacking both the transmission and spread of this disease by modifying a protocol being tested in another epidemiological battle – defeating Dengue Fever by using a bacterial endosymbiont, Wolbachia. This protocol capitalizes on the fact that this bacterium can affect a population of arthropods due to effects on fecundity, which causes Wolbachia to easily spread throughout a population. I have designed a mathematical model that modifies this protocol by infecting ticks with Wolbachia to reduce the spread of Lyme disease. My model introduces a new way of layering a dynamic system of seasonally based differential equations using Euler’s method combined with stochastic parameters, with the potential for extension into spatially discrete/geographically specific domains. The effect my model shows is that the greater the introduction frequency of Wolbachia infected ticks, the quicker the Lyme disease infected host population decreases. Therefore, this model is not only useful as a firm justification for field work to gather data on the dynamics of tick populations and the use of Wolbachia to combat Lyme disease, but could also be used to assist in tracking the progress of the field work itself.

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The use of Inscribed and Circumscribed Polygons around the Circle to Approximate Pi

Calvin Stanley
Loudoun Valley High School (LVH)

The purpose of this experiment is to utilize a different method for approximating Pi with the use of geometric polygons and circles. The project was set up by inscribing and circumscribing a regular polygon in and around a circle, then finding an approximation for pi using values found. From the data gathered, an equation was created to solve for a side length of a regular inscribed polygon within a circle as well as an equation for a circumscribed side. Conclusions drawn from this were that as more sides were added, the approximations became closer and closer to pi when set up as an inequality, so the alternative was supported. The independent variable changed the proximity of each the upper and lower bound of the values attained. Future research could explore whether this would work with polygons with even more sides and the use of a different medium than pencil and paper to find values, such as a computer.

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The Effect of Rubber Band Temperature on Hooke’s Law Constant

Suleman Waqar
Broad Run High School (BRH)

This project falls into the scientific category of mathematical science, since it pertains to the mathematical formula of Hooke’s law. The purpose of this experiment is to apply an everyday object to a famous mathematical formula. The procedure is simple, requiring only the heating and cooling of water and the placement of rubber bands in that water. The rubber band is then stretched with a force of 10 Newtons, and the results are plugged into the Hooke’s law to find out the value of the constant \(-k\). It turns out that as temperature increases, the Hooke’s Law constant decreases. At an average of 45 degrees Celsius, the Hooke’s law constant was 35. Also, at an average of 20 degrees Celsius, the Hooke’s law constant was 45. When the Pearson r test was applied to the results, the r-value was less that 0.01, which confirmed the validity of the experiment. With the results, it can be concluded that rubber band temperature has a large effect on Hooke’s law constant. The limitations to this experiment are the same type of rubber bands used, the type of thermometer used, and the amount of force applied to the spring scale.

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The Effects of Different Antacids in the Human Stomach

Sarah Adam
Potomac Falls High School (PFH)

Numerous Americans suffer with heartburn and have to experiment with themselves and waste their money finding the right antacid. The purpose of this experiment was to find the most effective antacid. The independent variable was the different antacid brands which were Alka-Seltzer, Tums, Gaviscon, and Milk of Magnesia, they were put with the hydrochloric acid solution which had a pH of three. Then the pH of the hydrochloric acid solution with the different antacids was recorded, which was the dependent variable. The control group was the hydrochloric acid solution. The most important finding of this study was that Milk of Magnesia had an average pH of 3.5, it neutralized the most acid compared to the other antacid brands which all had an average pH of three, the same as the control. A t-test showed that the data supported the hypothesis. The hypothesis was if different antacid brands are tested, then Milk of Magnesia will produce a pH closest to seven, proving it to be the most effective antacid. If further research was to be done in this area then a pH of one or two would be used since that is when indigestion and heartburn occurs, instead of a normal pH of three or four because antacids are meant for a pH of one or two.

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Investigating the Effect of (Z)-17-Methyl-13-Octadecenoic Acid on Colorectal Cancer Cells

Junaid Ahmed
Park View High School (PVH)
Academy of Science (AOS)

Polyunsaturated fatty acids (PUFAs) such as docosahexaenoic acid (DHA), an omega-3 PUFA, has been shown to be an anti-inflammatory to tumors and effective in preventing the acquisition of various diseases such as cancer and cardiovascular disease, while omega-6 PUFAs have been shown to have the opposite effect. The marine fatty acid (Z)-17-methyl-13-octadecenoic acid was planned to be tested on the colorectal cancer cell line HCT-116 at various concentrations. It was expected to be cytotoxic to the cells since other fatty acids of similar structure like punicic acid and omega-5 PUFA and other marine PUFAs have also shown to be cytotoxic. Cell culture growth was tracked through the rate of cell proliferation and no statistically significant difference exists between the 2.5 µM treatment and control groups. These results support previous research on the effect of marine fatty acids on cancer cells that have also found no difference between the 2.5 µM and control groups. However, the same researchers have concluded that higher concentration of fatty acid treatment has had a statistically significant impact on cancer cell growth. Further experimentation of more concentrated treatments must be continued to determine the effect of (Z)-17-methyl-13-octadecenoic acid on the colorectal cancer cell line at higher concentrations.

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The Effect of Biological Dyes and Vitamin D on the Neuronal Protein Stability and Health in Caenorhabditis elegans

Chang Chun
Dominion High School (DMH)

Neurodegenerative diseases are some of the most dangerous killers in society. One of the main causes for neurodegenerative disease is a loss of protein stability in the brain. Over time, organisms lose the ability to maintain neuronal protein stability. This leads to aggregates around synapses which deteriorate health. The purpose of this research was to determine if protein stability could be enhanced and hence the lifespan of Caenorhabditis elegans, a type of worm commonly used in neurodegenerative disease research, increased. Caenorhabditis elegans were divided into four plates and each plate was divided into 15 squares. One plate served as the control, one was subjected to thioflavin T, one was subjected to Congo red and one was subjected to vitamin D. Worms were then observed and their lifespans were noted as well as was their overall health. Statistical analysis via a t-test determined that Congo red and thioflavin T had no significant effect in extending the lifespan. However, statistical analysis via a t-test indicated that vitamin D significantly extended the lifespan of the Caenorhabditis elegans.

Further research would entail attempts to analyze the tertiary or quaternary structures of neuronal proteins to specifically determine how the substances are assisting in maintaining protein integrity. This is important because any new light shed on this matter could potentially lead to insight on treatment methods of neurodegenerative diseases.

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The Correlation of Diabetes, Obesity, and Lack of Health Insurance Across Specific Geographic Regions

Pooja Eagala
Tuscarora High School (THS)

This study looks at the percent population difference from the years 2008 and 2011 on diabetes, obesity, and lack of health insurance between five selected states from the northwest and southeast part of the United States. This information was gathered from the America’s Health Ranking website reviewed by the United Health Foundation. After performing a t-test, we can conclude that there is a significant difference in the percent population from the northwest and southeast region of the U.S for diabetes and obesity from the years 2008 to 2011 (p-value is less than 0.05). However, we can also conclude that there lies no significant difference in the percent population from the northwest and southeast region of the U.S for lack of health insurance from the years 2008 to 2011.

This study was important as looking at a State-Level Map for Diabetes and Obesity from the CDC (Center for Disease Control) map, there showed a significant difference between the northwest and southeast region. Therefore, I wanted to see if other factors may play a role in the increase in diabetes from 2008 to 2011.

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The Combined Effect of Curcumin and Paclitaxel on a Model of Idiopathic Pulmonary Fibrosis

Erin Fischer
Loudoun Valley High School (LVH)
Academy of Science (AOS)

Idiopathic pulmonary fibrosis is a fatal lung disease that affects roughly five million people worldwide. In these people, for an unknown reason, excessive fibrotic activity results in a morphological change in the lung epithelial cells that decreases gas exchange. These patients slowly suffocate. The goal of this research is to determine whether two drugs, paclitaxel and curcumin, used together can decrease fibrotic cell activity while encouraging epithelial cell growth. Paclitaxel was chosen because it is a chemotherapeutic agent that has been shown to exhibit anti-fibrotic activity. Curcumin has separately been shown to enhance the effects of paclitaxel and encourage epithelial cell growth. A working hypothesis for IPF is that for some reason, the lung cells turn on inflammatory pathways that result in epithelial cells becoming fibrotic. Thus combining the treatment might result in a slowing of disease progress. The results suggest that the addition of the two drugs is increasing epithelial growth and decreasing fibrotic growth. The addition of curcumin dosages to epithelial cells encouraged cell growth, with a p-value of .006. The addition of paclitaxel dosages to epithelial cells did not significantly decrease growth, with a p-value of .172. The addition of curcumin dosages to fibrotic cells did not significantly affect growth, with a p-value of .789. The addition of paclitaxel dosages to fibrotic cells significantly decreased growth, with a p-value of .001. Research on combination drugs, and whether the two drugs are more effective when used in combination, is ongoing.

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The Relationship Between Mercury and Autism

Caroline Fowler
Briar Woods High School (BWH)

The purpose of this project is to test whether mercury emissions from coal-fired power plants in the Commonwealth of Virginia affects the rate of autism. This will help determine a possible cause of autism. This theory suggests that as the amount of mercury emissions from coal-fired power plants increases, so will the rate of autism cases in surrounding counties. This project uses data on the number of reported cases of autism and the general population for each Virginia County along with the amount of mercury emissions from all coal-fired power plants located in Virginia. The autism rate for each county is compared in a graph to the amount of mercury emissions from coal-fired power plants prorated among surrounding counties. The Pearson r correlation coefficient is calculated to mathematically show whether a correlation exists between the two sets of data. The graph comparing the autism rate to the amount of mercury emissions for each county has essentially no correlation. The results do not support the hypothesis that if the amount of mercury emissions from coal-fired power plants increases, the autism rate in surrounding counties will increase. Further testing should be done to discover the true cause of the meteoric rise in the autism rate, thereby helping countless people affected by autism and saving money on skyrocketing healthcare costs.

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Plasma Rich Platelet (PRP) Treatment as a Regenerative Therapy

Cara Goode
Loudoun Valley High School (LVH)

The purpose of this project was to study the evolving PRP therapy in the treatment of, sometimes career ending, equine tendon injuries. The independent variable in this project was the type of cells used with the dependent being the effectiveness of the treatment. Animals that were observed during the duration of this project were all fit athletes who obtained an injury to the soft tissue in the foreleg. After being sedated, blood from the injured patient was drawn from the jugular, and then processed in a centrifuge to separate blood fractions that contained the highest number of platelets. Those cells were then extracted, mixed with plasma, which was also separated from the whole blood by the centrifuge, and then directly injected into the lesions in the injury site with the guide of ultrasound imaging. The treatment takes less than two hours which is crucial to the full recovery of a tendon. As the project developed, the "typical" tendon injury treatment, which includes shockwave therapy and steroidal injections, was documented to use as a comparison to the regenerative therapy treatment to further show the effectiveness, or ineffectiveness, of both treatment options. The patient being treated with standard shockwave therapy and injections regained soundness at the walk in four weeks as opposed to the standard projected time of regaining soundness which is six to eight weeks. As follow up examinations must still be conducted on both the standard and PRP treatments, conclusive data is still being collected. Further research could more closely explore the differentiation ability of the processed cells once they are extracted and injected back into the injury site.

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The Effect of Fatty Tissue on Heat Retention

Katie Goodwin
Heritage High School (HTH)

The purpose of the experiment is to determine how well fatty tissue retains heat. The conclusions of this experiment can determine the optimum amount of fat for the human being. The independent variable is the amount of fatty tissue surrounding synthetic blood; the dependent variable is the amount of heat retained over the course of one hour. The control sample was synthetic blood without any fat surrounding it. Begin the experiment by heating 200 mL of synthetic blood to 37 degrees Celsius. Place 1.3 centimeters of vegetable shortening around the beaker, recording temperature every minute for an hour, followed by the 2.3 centimeter and control sample. Proceeding the experiment, it can be concluded that the 1.3 sample of fatty tissue retains heat to the highest rate, concluding that for the human body, too much fat is not beneficial. The null hypothesis was accepted during an ANOVA test because the samples had a P of 0.13. The alternative hypothesis was that if there is more fat around the blood, then there is not more heat retained. To further the research, the procedures could have been improved to simulate the body more accurately by having real blood, allowing the blood to circulate through veins, and by using real fat.

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The Correlation Between Blood Type an Allergies

Elizabeth Hayes
Briar Woods High School (BWH)

Have you ever wondered if there is a correlation between a person’s blood type and his or her allergies? For this experiment, the correlation between the two was tested. Data was collected from local blood drives using a survey asking the participants blood type and their allergies. The independent variable was the person’s blood type and the dependent was the person’s allergies. Approximately eighty individuals were surveyed and the results showed a correlation between some of the blood types and allergies. First of all, it showed that blood group O had a more likely chance of having allergies than any of the others. It also showed that blood group B had a less likely chance of having allergies. Lastly, it showed that blood that contained the Rh factor (+) had a more likely chance too. The hypothesis was that there would be a correlation between the two and it was supported. It is now believed that the protein on the red blood cells either makes it more or less likely for the person to have allergies. Further research in this field of study could explore the correlation between allergies and race or the correlation between blood types and the flu and other illnesses. There are not any limitations in this field.

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The Effect of Astigmatism on People’s Drawing Abilities

Shahrozia Imtiaz
Loudoun County High School (LCH)

The purpose of this experiment was to determine if having astigmatism affects drawing abilities. Thirty-six subjects were tested to determine this. Sixteen subjects had astigmatism while twenty did not. All of the subjects were given the same art supplies and were instructed to draw a picture of a dog from an example that was placed 1.5m in front of them. They were asked to draw the same picture on graph paper and standard white paper. Subjects had fifteen minutes to complete the drawings and if they went over that time, a point was deducted from their final score. Subjects could earn a total of 6 points on the plain white paper and 5 points on the graph paper (the difference in the number of points is because they were only required to color the drawing on the standard white paper). An ANOVA test was used and showed no statistical significance between groups of normal vs. impaired vision for standard vision vs. graph paper (P>0.05). The results did not support the original hypothesis, “If the subjects with astigmatism use graph paper, then it would be easier for them to draw rather than using standard white paper” and the null hypothesis of no significant difference between the groups was accepted. The data was analyzed and the conclusion was drawn that not just the subjects with astigmatism but rather everyone drew better on standard white paper, so having astigmatism does not affect people’s drawing abilities. Further studies could include the subjects being asked to color their drawings that they had drawn on graph paper. If there were more subjects for each group, would the results be different?

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The Effect of Dental Sealants Protecting Teeth from Sugars and Acids

John Johnson
Tuscarora High School (THS)

Many people are using energy drinks and sodas nowadays to help keep them awake to complete daily tasks. The problem with this is these drinks contain high amounts of sugars and acids. These ingredients are very bad for teeth because it causes a strong potential for erosion of enamel. This problem is significant because these drinks are becoming very popular, especially among young kids and teens. Their permanent teeth are more vulnerable to attack from the acids found in soft drinks, due to the porous quality of their immature tooth enamel. As a result, there is high potential for erosion among this age demographic to increase. This experiment is designed to see how effective dental sealants protect tooth enamel from sugars and acids in different types of drinks. To test the effectiveness, the teeth will soak in different types of drinks with different levels of acid and sugar and the change in weight from the start to the end will be recorded. The decay can be measured by looking at the amount of weight loss in the teeth. Based on the results of a t-test, there is no significant difference between teeth coated with sealants vs. teeth not coated when exposed to citric, sorbic and benzoic acids (p-greater than 0.05). However, there is a significant difference between teeth coated with sealants vs. teeth not coated when exposed to glucose and maltodextrin (p-value less than 0.05).

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Do Colored Lenses Help Color Blind People Distinguish Colors Better in Real Life Scenarios?

Benjamin Kurzyna
Loudoun Valley High School (LVH)

The goal of this project is to determine if color blind people can differentiate colors better in real life scenarios using colored lenses. The independent variable is the lens color of the glasses. The dependent variable is the color vision performance of the test subjects. The control group is the round of testing with no lenses. An Ishihara color blind test was initially taken to determine which lens worked best under this standard test. The fruit test (putting different kinds of fruits in a order according to its ripeness) resulted in no statistically significant data with a P value of 0.1419. These results for the fruit test however, were skewed by the adults’ abilities to overcome their color blindness using their prior experience. The adults’ P value for the fruit test was 1.00 while the children had a P value of 0.0274. The experimental hypothesis for this project stated that using colored lenses would greatly improve the ability to distinguish color. This was not supported by the two ‘real life’ tests (Anomaloscope and fruit tests) because both of their P values were greater than 0.05. If the adults’ previous experience was factored out of the data for the fruit test, then the P value would be less than 0.05, therefore supporting my experimental hypothesis. If this project were to be continued, the number of test subjects would be increased to improve the reliability of the data.

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The Effect of Natural Oils in Preventing Ultra-Violet Radiation From the Sun

Charlotte Leidinger
Broad Run High School (BRH)

Natural oils contain an abundance of vitamins and nutrients that attract sunlight and prevent sunburns. Natural oils used as a sun protectant could provide natural ways for people to prevent ultraviolet radiation. The independent variable for this experiment is the natural oils used. The dependent variable is the level of ultraviolet radiation detected. The control group is the level of ultraviolet radiation detected on plastic wrap that does not contain natural oils. Oils will be placed on plastic wrap and after being subjected to direct sunlight for fifteen minutes the level of radiation will be detected and measured with a UV detector. The experiment was successful and significant because it provides insight to how easy it is to protect surfaces from the sun. The type of oil had a significant effect on its protection of the plastic wrap opposed to no protection of the plastic wrap. Coconut oil was among one of the most effective oils in lowering the level of ultraviolet radiation detected. Future research should be conducted in attaining information on more varieties of natural oils, and whether or not oils are more effective than sunscreen in preventing ultraviolet radiation on surfaces.

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Comparison of Heat-resistant Products and Amount of Damage to Hair After Straightening

Brittany Miller
Potomac Falls High School (PFH)

The theme of this experiment was human anatomy; furthermore, hair, and the purpose of this experiment was to see if heat-resistant products used before straightening reduced the damage to hair caused by a flat-iron. The independent variable in this experiment was the type of heat resistant product, and the dependent variable was the strength of the hair. The control group consisted of straightening hair without any product. The procedures for this experiment included straightening hair with application of a homemade heat-resistant product, commercial product, or no product and then testing the elasticity of the hair by adding weights to a single hair, stretching it, until breakage. The mean for the commercial product group was 31.93 cm, the mean for the homemade product group was 31.79 cm, and the mean for the control group was 31.36 cm. The t-test was performed to determine the significance of the raw data, and the outcomes showed that because the null hypothesis was rejected, the data was significant. Therefore, the hypothesis, the commercial heat-resistant product will result in hair having the most strength after straightening, was supported by the statistical test. The results and data showed that the commercial product group had hair that contained the most elasticity, which suggests it has the most strength. The information collected is interesting because it shows that using a heat-resistant product before straightening is significant in respect to the health of hair.

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The Effect of Toluidine Blue O-Mediated Photodynamic Treatment on Staphylococcus epidermidis Biofilms

Tessa Peak
Stone Bridge High School (SBH)

The Photodynamic Treatment (PDT) is a process that exposes microorganisms to non-toxic photosensitizing dye followed by low-intensity visible light. The experiment evaluated efficacy of Toluidine Blue O (TBO)-mediated PDT to eradicate of Staphylococcus epidermidis biofilms on surgical implants that can cause nosocomial infections.

200µl S. epidermidis diluted at 1:200 (0.1mL in 20mL TS Broth) was inoculated into 3 sets of tubes and incubated for 16hrs at 37°C. 100µl of 80µM TBO was added to S+L- (TBO, no light), S+L+ (TBO, light) whereas S-L- (no TBO, no light) received 100µl saline and were incubated in dark for 30min at 37°C. S+L+ were irradiated with 640-nm laser for 45mins. After homogenizing, the samples were diluted, plated and incubated at 37°C for 24 hours and CFUs (DV) were counted.

T-test for (S-L-) and (S+L+) shows statistically significant difference (P<0.05) in CFUs indicating that TBO followed by light exposure can eradicate more cells thus supporting the alternative hypothesis. The photochemical reaction generates singlet oxygen that exerts bactericidal effect thus reducing CFUs.

ANOVA did not show significant difference (P>0.05) in CFUs in S+L-, S+L+, S-L-. T-test for (S+L-) and (S+L+) and for (S-L-) and (S+L-) shows no significant difference (P>0.05), indicating TBO killed cells in presence or absence of light (possibility of an error could be due to unintended exposure to visible light).

The further experimentation can explore effect of other PS dyes and PDT on gram negative bacteria. In order to use effectively in periodontal procedures, PDT needs to be tested under anaerobic condition. PDT can be explored in vivo, as an alternative to minimize the use of antibiotics that may promote resistance.

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Impact of CYP2C9 Promoter Variation and the VKORC1 1639G>A Polymorphism on Stable Warfarin Dose

Alexander Varzari
Dominion High School (DMH)

Warfarin (Coumadin) is the most widely used oral anticoagulant. At the proper dose, warfarin is extremely effective at preventing blood coagulation. However, warfarin overdose can lead to excessive bleeding and hemorrhage. Cytochrome P450 2C9 (CYP2C9) is the most important enzyme for inactivating warfarin in the liver leading to the drug’s elimination. Individuals who have certain genetic variations in CYP2C9 require a lower dose of warfarin. The focus of this research was to sequence the promoter region (from -2453 to -3124) of the CYP2C9 gene and to determine whether genetic variation within this region was associated with lower warfarin dose. The promoter was focused on since none of the patients had any known CYP2C9 variants and the promoter is not in linkage disequilibrium with any of these variants. In addition, the research sought to determine whether promoter variation, in combination with the 1639G>A polymorphism of the VKORC1 gene (the cellular target of warfarin), was associated with warfarin dose.

Interestingly, a 420 bp deletion, discovered in the CYP2C9 promoter, was detected in 3/19 patients. The patient population was divided into three different genotypes: those with no alleles in either gene, those without DeltaG-2664DeltaT-2665 but with one 1639G>A haplotype, and those with both DeltaG-2664DeltaT-2665 and one 1639G>A allele. It was interesting that any patient exhibiting the DeltaG-2664DeltaT-2665 also had the 1639G>A. As a result, the groundwork has been laid for further research which would include sequencing the rest of the CYP2C9 promoter to locate other polymorphism associated with low warfarin dose.

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The Predictability of the Catalytic Function of Enzyme Proteins Based on their Primary Structure

Priya Venkatraman
Briar Woods High School (BWH)

The purpose of this experiment was to analyze the predictability of the catalytic function of enzymes based on their primary structure. The hypothesis was supported by the results of the experiment conducted since a strong Pearson R correlation of 0.97 was found between the function and the structures of the proteins. The peptides they have in common suggest their relationship in protein folding and ultimate function. The biological process can be inferred from the sequence or structural similarity for example both proteins affect the G2 phase of the mitotic cell cycle, neuron apoptosis, and protein phosphorylation among many of their other functions. The unknown protein also has molecular function as suggested by its similarities to the Amyloid beta precursor A4 protein. It plays a role, for example, in DNA binding, and acetylcholine receptor binding. The mathematical relationship between the Amyloid beta precursor A4 protein and the unknown protein is based on their amino acid sequences. A central problem in biology that has perplexed researchers is the complex folding process of proteins as they transform from amino acid chains into intricate structures. Alzheimer's is caused by an accumulation of protein clumps in the brain occurring due to peptide remains from the cutting of the Amyloid-beta precursor protein. These studies could potentially enable researchers to explore broader questions about the evolution of proteins. It opens the way to designing and engineering artificial proteins and can lend insight into cures for diseases like Alzheimer's.

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Investigation of the Effects of Basic Fibroblast Growth Factor/ Ciliary Neurotrophic Factor Combination Treatment on the Growth Rate of a Huntington’s Disease cell line

Emma Ward
Heritage High School (HTH)
Academy of Science (AOS)

Huntington’s disease (HD) is an autosomal-dominant, fatal, neurodegenerative disorder that is characterized by neuronal loss in the cerebral and striatum cortexes of the brain. Currently there is no effective treatment for HD. One potential treatment strategy involves the replacement of dead neurons by stimulating proliferation of functioning neurons in damaged regions of the brain. The role that basic fibroblast growth factor (FGF-2) and ciliary neurotrophic factor (CNTF) might play in neurogenesis as a potential therapeutic treatment option for Huntington’s disease was investigated in this study. FGF-2 is an established neuroprotective agent and in some settings can even promote neurogenesis, while CNTF counteracts the negative effects of FGF-2 and serves as an additional protective agent for neural cells. Rat neuronal cells CHD1-90000065, induced with molecular Huntington’s disease characteristics, were cultured and treated with FGF-2 and CNTF individually and as a combination treatment. I report here that FGF-2 and CNTF when used as a combined treatment at the concentration of 20 ng/mL of each had a significant increase (p=1.79x10⁻⁵) in cell growth and cell proliferation over the control groups; concluding, that the optimal cell proliferation of the HD cell line occurs when a combination treatment is used to grow the cells.

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What Is the Most Effective Way to Clean a Toothbrush?

Erin Bradley
Park View High School (PVH)

With thousands of bacteria living on a toothbrush, this experiment was designed to find the most effective method to clean a toothbrush. The independent variables of the experiment were the solutions used: white vinegar, distilled water, air-dry, hydrogen peroxide, and FreshBurst® Listerine® Antiseptic Mouthwash, while the dependent variable was the colony count of bacteria. The experiment's control was air-drying the toothbrushes for ten minutes. The experimenter swabbed all toothbrushes with living, K-12 strain of Escheria coli, then soaked them in the different solutions. The toothbrushes were swabbed onto agar plates before and after all methods; the two were compared to measure which solution had the greatest impact on the colony count of bacteria. The results of the experiment support that FreshBurst® Listerine® Antiseptic Mouthwash had the greatest effect on the bacterial colony count. The t-values showed that compared to the control, for FreshBurst® Listerine® Antiseptic Mouthwash was 9.4596. The t-test results of the other methods are as followed, all are compared to the control, distilled water equaled 1.1198, hydrogen peroxide equaled 4.703, and white vinegar equaled 6.4186. The experimental hypothesis, if soaked in different solutions there will be no effect on the colony count, was not supported by the data collected. The independent variable had an effect on the amount of colonies, supporting that toothbrushes should be cleaned to kill bacteria. One source of error was that white vinegar killed the blood agar plates. Further research could explore which solution kills a wider range of bacteria.

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The Effect of Dandelion Root and Peppermint Leaf on E. coli

Lauren Brill
Loudoun Valley High School (LVH)

The purpose of this experiment was to figure out if dandelion and peppermint are effective at inhibiting the growth of E. coli. The independent variables in the experiment are dandelion root and peppermint leaf. The dependent variable was the rating of the amount of E. coli growth given to each Petri dish. The experiment was performed by spreading a dandelion root/water solution on five Petri dishes and a peppermint leaf/water solution on five dishes. The remaining five were left untreated (control group). Each Petri dish was inoculated with E. coli. They were left in an incubator at 37° for 48 hours. Finally, each dish was given a rating on the amount of bacteria growth (1-10). The Petri dishes with the peppermint received a rating of 1; the dandelion, a 10; and the control, a 3. This means that there was very little growth in the peppermint dishes, uncontrolled growth in the dandelion root, and relatively normal growth in the control. A Wilcoxon test was performed, which indicated there was significant difference between the ratings of the peppermint and control, but not in the dandelion and control. Therefore, the experimental hypothesis stating that the dandelion root would better control the growth of E. coli was rejected. If additional experiments were conducted, then a possible way to get better results would be to infuse liquid agar with the dandelion and peppermint powder, and use sectioned Petri dishes so that each would be exposed to the environment for an equal amount of time.

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The Effect of Genetic Variation in Escherichia coli on the Virulence of the Lambda Bacteriophage

Evan Cowling
Tuscarora High School (THS)

The current method of genetic tests is flawed; it costs a lot of money, and the actual test may take a long time to complete. Viruses select what to infect based off DNA, so if the DNA is slightly different, a virus might be able to detect the difference. If the virus goes through lysogenic conversion, the whole culture could change a physical property, such as color, quickly. This would make genetic testing much quicker and potentially much cheaper. An experiment was conducted to see how specific a virus is to its host. The lambda bacteriophage and its host, Escherichia coli, were selected due to their low hazardous potential coupled with the wide variation in E. Coli Genomes. E. coli strains B, C, C600, and K-12 were cultured in a tryptic soy broth. 50 µL of each strain, each at a .5 McFarland standard, was added to a cuvette holding 50 mL of the broth. Each strain was measured for % transmittance at different points, both before and after the Phage was added, and before and after each trial was subjected to UV light for 30 minutes. The purpose of the UV light is to lyse the bacteria which are infected by the bacteriophage. Strains C and B were shown to be statistically different from K-12 and C600, while C and B as well as K-12 and C600 were shown to be not statistically different. One may conclude that both strains B and C were infected, while K-12 and C600 were not. The results of this experiment are not conclusive as to whether or not a future of using viruses to detect genetic diseases is plausible or not. However, the future does look a bit brighter in this regard, as viruses can discriminate within a species.

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Life on (or in) a Musical Mouthpiece

Bryce Dowling
Potomac Falls High School (PFH)

In a society where music benefits from increased popularity there is a microscopic threat that silently targets musicians – namely instrumentalists. Commonly overlooked, hundreds of microbial colonies grow and prosper on the surfaces of saxophone and trumpet mouthpieces alike. In order to better appreciate this implication, an experiment was conducted comparing the number of bacterial colonies on those woodwind and brass mouthpieces respectively. Bacteria was vortexed from used mouthpieces (both types) and inoculated onto an agar plated for observation after being incubated. Due to the vast number of colonies present, a qualitative scale (0-10) was used to provide definitive measurements. After seven trials per test group, the average number of bacterial colonies on woodwind (saxophone) mouthpieces (6.79) proved to be greater than brass (trumpet) mouthpieces (only 1.92). Resultantly, the original hypothesis was supported; that woodwind mouthpieces would harbor more microorganisms. This outcome is most likely because woodwind reeds are significantly more porous than the comparatively hard, cold surface of brass. Because mouthpieces are exposed to the elements and therefore potentially less hospitable, further research of bacterial growth inside the instrument is recommended. Such follow-on examination would likely produce more thorough and statistically significant results. Regardless, this study helped further emphasize the point that instruments are ideal locations for microbial growth and necessary maintenance precautions should be taken to reduce the risk of potential bacterial-borne illness.

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Blueberries have antioxidants that can prevent oxidative stress and cell damage caused by free radicals, which otherwise are responsible for aging and other disorders. The experiment compared the efficiency of the antioxidizing potential of 0.7g/mL blueberry extract (IV) and 0.0006mg/mL Vitamin C (IV), in protecting Saccharomyces cerevisiae cells (yeast) from oxidative damage caused by oxidizing agent (50µL H2O2) to determine the protective effects of antioxidants supplements and surviving cells (CFU - DV) were counted.

Though not statistically different more, average CFUs were more in “Blueberries+H2O2” (28.6, variance 81.3) as compared to “Vitamin C+H2O2” (19.8, variance 27.7) and “No supplement+H2O2” (18.4, variance 44.8) indicating blueberries protected the cells better than Vitamin C against oxidative damage. Blueberries will most likely protect human cells from oxidative damage as well, due to similarity in Saccharomyces cerevisiae and human genes used to repair DNA.

The ANOVA and T-test showed no significant difference (P>0.05) in CFUs in “No supplement+H2O2” and “Blueberries+H2O2” indicating that blueberries protected against oxidative damage, but not significantly. There was no significant difference (P>0.05) in CFUs in “No supplement+H2O2” and “Vitamin C+H2O2” and in “Blueberries+H2O2” and “Vitamin C+H2O2” thus refuting the alternative hypothesis.

The anti-oxidizing potential of blueberries could have decreased due to denaturation of vitamin. Higher concentrations of blueberry extract can be used to provide sufficient protection to cells against oxidative damage.

Further research can compare different Vitamins to fruits and vegetables having respective vitamins. The effectiveness of blueberries in providing protection against other mutagens, such as UV rays, could be explored.
Food that Kills: The Effect of Natural Substances with Antibiotic Properties on Bacteria

Rebecca Giles
Tuscarora High School (THS)
Curtis Hart
Tuscarora High School (THS)

Antibiotic resistance is a problem in the medical community as bacteria evolve and become immune to known antibiotics more rapidly than they are discovered. The purpose of this experiment is to explore alternate remedies to which bacteria are not yet resistant. Substances including garlic, vinegar, onion, Bhut jolokia, Urena lobata, water, and penicillin were tested to conclude which has the greatest effect on three different strains of bacteria: Escherichia coli, Streptococcus salivarius, and Staphylococcus epidermidis. Water serves as a control and is used for comparison purposes along with penicillin. Success of each remedy is measured and compared using their zone of inhibition. Garlic was most successful with a mean zone of inhibition of 2.488 cm, followed by penicillin with 2.058 cm, while onion and water had the least effect, with 0.075 cm and 0.100 cm, respectively. Using t-tests it was found that garlic, vinegar, and penicillin were consistently able to reject the null hypothesis with p-values below 0.05. However, Urena lobata, Bhut jolokia and onion were the only substances that failed to reject the null hypothesis with any type of bacteria. The hypothesis that certain natural substances can kill bacteria was conditionally accepted. Based on the data, some substances including garlic, vinegar, and penicillin accept the alternate hypothesis, and therefore can be helpful against resistant bacteria. Further research could explore if the substances remain successful against stronger bacteria pathogens. A question arose when some Urena lobata trials produced a type of mold that seemed to be more successful than the Urena lobata plant itself.

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Imagine doctors washing their hands; the purpose is to kill as much bacteria as they can with the pressure to keep the earth “green”. This experiment tests two types of soap in order to observe the amount of bacteria killed. Isopropyl alcohol was used as the control while Dr. Bronner’s all-natural “baby mild” liquid soap and Ivory Liquid Clear Soap were the independent variable. The dependent variable was the diameter of the zone of inhibition in Escherichia coli (E. coli). These solutions were blotted on blank disks then incubated at 32 degrees Celsius for 48 hours. Next, measurements were taken; Dr. Bronner’s soap conveyed three unusual rings of growth around the bacteria. Scientists from Dr. Bronner’s company claim that “brown stuff may have been left on the equipment”. The mean diameters for the zone of inhibition for Isopropyl alcohol, Ivory Liquid Clear Soap and for the all-natural soap’s 3rd ring were 9.5 mm, 31.4 mm, 32.6 mm, and 16.8 mm respectively. After taking the measurements, statistical analysis (F-stat, T-stat) were completed to determine equal variances and significant differences. All the solutions had equal variances with significant differences in all the solutions. The alternative hypothesis “If Dr. Bronner’s “Baby Mild” all-natural liquid soap is used, then the zone of inhibition will be larger than if Ivory Liquid Clear Soap is used” wasn’t supported by Table 2: ivory liquid soap had a greater T-critical than all-natural soap. Further research could explore densities of the three solutions and its impact on the effects.
The Impact of Photoreactivation on the growth of Saccharomyces cerevisiae

Benjamin Kellogg
Loudoun Valley High School (LVH)

Ultraviolet radiation can cause severe damage to the DNA of a cell. The focus of this experiment was to discover how effective photoreaction was in repairing this damage in yeast cells compared to dark repair methods. Photoreaction is caused by an enzyme called photolyase which is activated by visible wavelengths of light. This enzyme repairs pyrimidine dimers or bulges in the DNA caused by UV light. All dark repair does is cut the DNA sequence out and replace it. In this experiment yeast was grown on agar plates and then irradiated with UV light measuring 254 nm (nanometers) for two and a half minutes in order to damage the DNA. The photoreactivation group was then irradiated with visible light measuring between 320 to 600nm for half an hour in order to activate the photolyase. Once the yeast was grown, the colonies on each plate were counted. The Photoreactivated yeast had an average of 59 colonies while Dark repair had 40. Using a t-test it was shown that the results were significantly different and there was a less than ninety-five percent chance that the results happened by chance. Therefore the hypothesis that Photoreactivation would be much more effective in repairing the yeast than dark repair was supported. Further research can be done to expand the experimental group to include other organisms that can do photoreactivation. Also it could test to see if one of the groups contained more mutations than the other.

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The Effect of Whether or Not a Bacterium is Encapsulated on the Bacterium’s Resistance to Antibiotics

Arianna Laghaeian
Heritage High School (HTH)

Bacteria are considered to have been conquered in microbiology; however, bacteria have provided another obstacle: capsules, or barriers outside the cell wall of certain bacterium. The purpose of this experiment was to test the effects of capsules and determine if they provided increased resistance against antibiotics. It included an IV of bacterial capsules, a DV of antibiotic resistance, and a control of a non-encapsulated bacterium: Staphylococcus aureus. Petri dishes were inoculated with three encapsulated bacteria, Streptococcus pneumoniae, Haemophilus influenzae type b, and Streptococcus agalactiae; and one non-encapsulated bacterium, S. aureus. Three disks of antibiotics—Ampicillin, Vancomycin, and Gentamycin—were placed in each petri dish, and after five days in incubation, the inhibition zones of each were measured. The results were as follows: S. agalactiae had a mean zone of 19.933 mm with ampicillin, 14.467 mm with vancomycin, and 0 mm with gentamycin; S. pneumoniae had 38.6 mm, 17 mm, and 9.533 mm; and H. influenzae type b had 33.533 mm, 6.667 mm, and 18.2 mm; the means for the control, S. aureus, were 48.2 mm, 17 mm, and 24 mm, respectively. The ANOVA statistical test determined a P value of 0.00, meaning the alternative hypothesis of “If a bacterium is encapsulated, it will have a larger resistance to antibiotics,” is accepted. This concludes that the capsules influenced the antibiotic resistance by having a higher resistance compared to the control. Regarding further research, questions include if capsules require a higher concentration of antibiotics to be killed, and whether or not capsules affect bacterial mutation.

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Natural Extract’s Effect on Extracellular Polymeric Substances (EPS) in Biofilm Dispersal

Kavya Mathur
Dominion High School (DMH)

Natural disasters such as tsunamis, hurricanes and floods initiate the spread of disease through the destruction of pipelines and infrastructure. Communities of microorganisms called biofilms form due to the attachment of microbes to extrapolymeric substances (EPS). The microorganisms that make up biofilms are less harmful in their free-floating state than when attached to one another. The purpose of this research was to determine whether herbal (ginger) and fungal (polypore mushrooms) extracts could cause the breakdown of extrapolymeric substances (EPS) produced by Vibrio fischeri and Bacillus subtilis in order to cause biofilm dispersal. Vibrio fischeri and Bacillus subtilis were allowed to form biofilms and were subjected to ginger and polypore fungal extracts. Methylene blue dye was added to cultures in order to determine biofilm breakdown by measuring dye color intensity over a period of 6 days. Statistical analysis via t-test determined that there was a significant breakdown in the biofilm’s extracellular matrix (EPS) when subjected to both extracts. Ginger had a greater effect on the breakdown of the EPS subsequently causing greater biofilm dispersal than polypore mushrooms. Hence, substances such as ginger and polypore tree fungi which may prevent biofilm formation and disease outbreak.

Further research would entail testing additional substances which are commonly available in countries which often experience natural disasters such as tsunamis and hurricanes to determine the further viability of biofilm remediation. This may provide low cost methods of limiting the spread of waterborne diseases.

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The Effect of Antioxidants on Percent DNA present in the “Tail” of S. cerevisiae strain BY4741 Using Comet Assay when Exposed to 0.3% Hydrogen Peroxide

Grace Morales
Freedom High School (FHS)

Antioxidants are an everyday substance marketed in stores claiming health benefits like cancer prevention and mending of oxidized DNA. The experiment tested antioxidants down at the cellular level and their ability to protect S. cerevisiae, strain BY4741, from oxidizing agents in order to find if the said claims made by products are true. It used single cell gel electrophoresis (SCGE or Comet Assay) to find if different antioxidants produced similar percentages of damaged DNA. Slides of treated BY4741 were submitted to electrophoresis and analyzed under a fluorescent microscope with the help of comet scoring software. While pomegranate and blueberry protected the DNA of BY4741 well, pomegranate worked best by 1.6% mean. The acai on the other hand was statistically similar to the H2O2 and only acai samples. Further research can be done with this technique using other organisms and their reaction with other antioxidants, including Vitamin C, green tea, and Vitamin E when exposed to an oxidizing agent, such as UV radiation or chemicals like Chlorine (Cl2).

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The Effects of Natural Repellents on the Growth and Development of Agrobacterium tumefaciens in Phaselous lunatus

Neha Onteeru
Potomac Falls High School (PFH)

Each year thousands of plants die from a Crown gall, strain of plant cancer caused by the pathogen Agrobacterium tumefaciens. The purpose of this experiment was to find out what type of natural repellent, if any, restrained the growth of A. tumefaciens the most efficiently. The independent variable was the type of natural solution given to infected lima bean plants, either cayenne pepper solution, mint solution, or garlic solution; and the control group was the set of plants only given water. The dependent variable was the size of the cancerous tumors that developed on the roots and bases of the plants. Lima bean plants were sprouted and grown, then infected with the bacteria, and then watered with their respective solutions every other day. The average size of tumors in each of the groups after a two week trial period were 0.19cm for the control group, 0.15cm for the cayenne pepper solution group, 0.22cm for the garlic solution, and 0.18cm for the garlic solutions. Through an ANOVA test, the p-value was 0.71 and so the hypothesis of cayenne pepper being the best repellent was not supported. For further research scientists could explore the effects of the repellents for a prolonged period of time rather than a shorter period. The discovery of an effective natural repellent for Crown gall could save millions of dollars for all agricultural institutions.

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The Effect of Pool Depth on Bacteria Level

Shannon Song
Woodgrove High School (WHS)

The purpose of this experiment was to determine whether the shallow end of a swimming pool or the deep end of the pool contained more bacteria. The independent variable was the area of the pool tested and the dependent variable was the amount of bacteria found. There was no control group assigned to the experiment because it was a comparative study. To test the pool, a test strip would be dipped into the surface of the indicated testing spot and then transported to an incubator, where it sat for 48 hours at the specified temperature. It was then read and the results were recorded. The shallow end did have more bacteria present, however the amount of bacteria found in the pool was shocking. Both pools exhibited the highest amount of bacteria possible according to the test strip. The mean for the shallow end of the pool was 4.669E+08 bacteria/mL, while the deeper end of the pool had a mean of 1.004E+08 bacteria/mL. The hypothesis that the shallow end of a pool would have increased levels of bacteria, was supported. According to the statistical results the shallow end had a variance of 1,014,450,289.83, 4.04486E+08 higher than the deeper end, and a standard deviation of 5.072E+08, which is 2.022E+08 higher than the deep end of the pool. This demonstrates that the independent variable influenced the dependent variable. Further research could test the effect of numbers of swimmers and bacteria levels, at each end of the pool.

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The Effect of Multiple Antibiotics on the Zone of Inhibition of E coli k-12.

Evelyn Soon
Freedom High School (FHS)

There are presently many different antibiotics on the market for doctors to prescribe. This experiment was designed to determine if antibiotic combinations can be more effective at killing bacteria than a single antibiotic type. It tested the effect of 3 Ciprofloxacin disk, 1.5 Ciprofloxacin and 1.5 Tetracycline, and 1 Ciprofloxacin, 1 Tetracyclin, and 1 Penicillin on the zone of inhibition (mm) of E. coli growth. Each condition was tested fifteen times. In pre-tests it was determined that Ciprofloxacin produced a larger zone of inhibition than Tetracyclin and Penicillin. Therefore it was made the control. The dependent variable was the diameter of the zone of inhibition which was measured after two days of bacterial growth. Using the t-test, results showed that there was a significant difference in the zone of inhibition for each group; however, the difference was the decrease in effectiveness with less ciprofloxacin. The average zone of inhibition for the Ciprofloxacin was 45.13 mm, the Ciprofloxacin and Tetracycline was 40.6 mm, and all three combined was 39.93 mm. The experimental hypothesis was therefore not accepted. Antibiotics should be taken in recommended dosages and increasing the amount or the variation does not help inhibit or kill the growth of bacteria more rapidly. With the experiment being conducted in a school environment, there were a few restrictions. If given the opportunity, a question could be explored is if multiple antibiotics increase antibiotic resistant strains of bacteria.

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Analyzing the Effects of an Attractant (Aspartate) for Escherichia coli on the Chemotactic Response of Other Enterobacteriaceae

Edward Tiernan
Stone Bridge High School (SBH)
Academy of Science (AOS)

The Enterobacteriaceae bacterial family, with species like E. coli and Salmonella, causes infections in the intestines of hundreds of thousands of people each year. My research focuses on taking aspartate, an amino acid that is known to have a chemotactic relationship with E. coli, and seeing if that relationship is replicated in other members of the family. Several species of Enterobacteriaceae were cultured in minimal media, and then their chemotaxis was assayed in the presence of aspartate and compared to a negative control of bacteria without any amino acid, and an additional control of bacteria supplemented with a different amino acid, glycine. E. coli was used as a positive control. The results of this experiment show that H. alvei exhibits chemotaxis in aspartate as opposed to glycine with a 96% confidence (p = .036) in a 1 tailed t-test. The control group E. coli also showed chemotaxis but with a lower confidence of 92% (p = .082). Experiments are underway to test for aspartate chemotaxis in E. ictaluri and K. cryocrescens. If the aspartate chemotaxis continues to be conserved in the Enterobacteriaceae family, then it is reasonable to conclude that other members of the Enterobacteriaceae family will exhibit the same behavior, including killers like Salmonella. Aspartate may be useful as a future medicine against intestinal infections, especially because aspartate, as an amino acid, has virtually no adverse affect on the human body.

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The Effects of Water on Bacteria

Justin Touve
Potomac Falls High School (PFH)

Every year thousands of people get sick due to cross contamination of food with dangerous bacteria from raw chicken during the food preparation stage. The majority of these cases could be reduced by simply rinsing cutting boards and knives with water that is 70 C or hotter. This experiment tested the effectiveness of water alone at certain temperatures on reducing bacteria on food preparation utensils. Water at room temperature, 50, 70, and 100 C was used. The remaining bacteria were cultured to determine how effective the water was at reducing the amount present. All results were compared to the amount of bacteria that was cultured after being exposed to room temperature water. The results showed that the hotter the temperature of the water, more bacteria was destroyed. An ANOVA test was used to identify the quantitative data and 4 divisions per inch graph paper were used to measure the data. When room temperature water was used, an average of 45.25 squares were filled, an average of 44.25 squares were filled when 50 C water was used, an average of 33.25 squares were filled when 70 C water was tested and an average of 23.5 squares were filled when 100 C water was tested. The hypothesis of the experiment was that if you use 70oC water on bacteria, then more bacteria would be killed. The results support the hypothesis because 70 C water killed more bacteria than the other water temperatures except for the 100 C water.

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The Effect Of Triclosan Exposure On The Antibacterial Sensitivity of Escherichia coli

Viruthika Vallanadu
Stone Bridge High School (SBH)

Triclosan is an antibacterial common in household, personal care products that may hold risks to health and the environment. Wastewater treatment cannot remove Triclosan and it may get converted into dioxin. Its byproduct is lipophilic, bioaccumulative and toxic to algae, invertebrates and fish. Triclosan's mode of action and target site in bacteria is similar to antibiotics. Triclosan exposure may trigger a cross resistance to antibiotics/antimicrobials. The experiment investigated the effect of Triclosan exposure on the reduction of antibacterial sensitivity of Escherichia coli.

E. coli “Exposed” (IV) to Triclosan and “Unexposed” (diluted 10E5 cells/mL) was used in drug-susceptibility tests (MIC broth method and MBC sub-culturing) and CFUs (DV) were compared with un-inoculated control (no Ampicillin no culture) and control (Ampicillin no culture).

T-tests show statistically significant difference (p<0.05) in CFU “Unexposed” and “Exposed” prior to treatment of 0.5mg/L, 1mg/L, 2mg/L, 16mg/L with higher CFUs in “Exposed” than “Unexposed” on N. agar thus supporting alternative hypothesis. T-tests did not show significant difference (p>0.05) in 4mg/L, 8mg/L Ampicillin. ANOVA shows statistically significant difference (p<0.05) in CFU “Exposed” and “Unexposed” for all concentrations with least CFUs in 32mg/L Ampicillin. MBC for “Exposed” and “Unexposed” were equal thus refuting the alternative hypothesis.

Ampicillin susceptibility for E. coli had not altered significantly but Triclosan exposure resulted in increase in survival rate at lower concentrations of Ampicillin. Triclosan blocks the active site of the enzyme ENR and prevents bacteria from synthesizing fatty acid necessary for cell membranes and reproduction.

Future research can investigate whether antibiotic susceptibility of E. coli towards chloramphenicol and other antibiotics is reduced with repeated Triclosan passages. The different strains of E. coli could be tested to determine whether resistance is strain specific.

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The Effect of Magnetism on the Growth of Escherichia coli in Organic Produce

Michael White
Woodgrove High School (WHS)

The purpose of the experiment was to observe whether magnetism could reduce the growth of bacteria, so it could be used on organic produce to extend shelf life. This could then serve as a substitution for preservatives, without the negative health effects. The independent variable was the amount of magnetism, in gauss, a petri dish of Escherichia coli was exposed to, with the control group 0 gauss. The dependent variable was the percent of the petri dish covered with Escherichia coli in a 2.5 cm radius around the center. This was measured after 24 hours, and later again after 48 hours. The percent of coverage at 48 hours was subtracted by the percentage at 24 hours to get the change in growth.

The results of the experiment showed that magnetism did have an effect on the growth of bacteria. When exposed to magnetism, the bacteria grew more constantly, with a standard deviation of 5.47 for the control, 4.8 for the 14800 gauss group, and 3.34 for the 13200 gauss group. The Mean for the control was 9.5 percent, but when exposed to 13200 gauss of magnetism, it was reduced to 6.83 percent, and 5.67 percent for 14800 gauss. The changes in the mean supported the hypothesis, that if organic produce was exposed to magnetism, then the growth of Escherichia coli would be inhibited. This knowledge could be used for food preservation techniques, and further research could be done to see how magnetism affects bacteria growing on organic produce.

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Investigating the Effect of Antioxidants Found in Dark Chocolate on the Growth of Propionibacterium acnes

Amanda Wong
Dominion High School (DMH)
Academy of Science (AOS)

The bacterium Propionibacterium acnes plays a role in the inflammation of acne blemishes. Polyphenols are a subgroup of antioxidants, and in previous studies, the polyphenol resveratrol has inhibited the growth of P. acnes. Therefore, the goal of this study is to determine if polyphenol antioxidants in dark chocolate are able to inhibit the growth of P. acnes. A dark chocolate antioxidant solution was created and split into two solutions: one that was sterilized through the use of 0.22 micron filters and one that was autoclaved. Four concentrations of dark chocolate extract were created from each of these solutions, and their antioxidant activities were determined through the DPPH assay. The effect of these concentrations on the growth of P. acnes was determined through the disk diffusion method. Distilled water and the antibiotics doxycycline, erythromycin, and tetracycline were used as controls. Zones of inhibition were measured to determine the antimicrobial effects of the concentrations and controls. The DPPH assay indicated that the concentrations contained antioxidants; however, no zones of inhibition were found for any of the antioxidant disks with concentrations varying from 1x to 1/64x. Further testing was carried out for concentrations as high as 10x, but no zones were observed.

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The Effect of Musical Notes on the Resonance of a Drum's Snares

Jacob Brummond
Freedom High School (FHS)

This project is exploring the concept of musical resonance, and if a correlation exists between resonance and frequencies (notes). The purpose of this experiment is to be able to reduce resonance between different musical instruments. Vibrations from instruments can cause undesirable sounds, which can be prevented by identifying and avoiding these frequencies. Two different snare drums were tested with snares on and snares off (control group), by each frequency on the piano (IV) played to determine the amount of resonance (DV). The test was done by recording data from a decibel sound meter with a robot programmed to strike each piano key. Through this experiment, over one-third of the data is considered valid by the t-test. One note (F#/Gb4) in particular was higher than all of the other notes, with the difference (between the snares on and off) a mean of 12.36 decibels with one snare drum, and 11.43 on the other snare drum. Many other statistical tests were used, including standard deviation, range, variance, and the Pearson test. The hypothesis of a correlation between frequency and resonance is apparent in some frequencies, but further research would have to be done to confirm this hypothesis. The results had strong similarities between the two different snare drums, showing that the snare drums were affected by mostly the same frequencies. In further research, the idea of a correlation between frequency and resonance and how chords (multiple notes played at the same time) have an impact on resonance could be explored.

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The Effect of Different Substances on the Decibel Level of an Alto Saxophone

Tina Chiu
Park View High School (PVH)

This experiment is to see if different substances can change the decibel level on a saxophone. The independent variables are the substances that the reeds are soaked in: white vinegar, distilled water, 50% baking soda solution, and Listerine®. The dependent variable is the decibel level. The decibel for a reed soaked in nothing is the control. In this experiment, reeds will be soaked in the different liquids and then used on an alto saxophone. A decibel meter will show the decibel for each reed. The results for this experiment is that there is no significant difference for distilled water (p-value 1) and Listerine® (p-value 0.2990), but there is a difference in white vinegar (p-value 0.0001) and baking soda (p-value 0.0014). The mean for white vinegar is 66.5 dB, distilled water was 65 dB, baking soda solution had a mean of 66.03 dB, and Listerine® was 65.33 dB. The alternative hypothesis is, if a reed is soaked in different substances then the decibel level will change. The alternative hypothesis was refuted because distilled water and Listerine® did not show significant difference. The independent variables did have an effect on the dependent variables; some substances do affect the decibel level of the alto saxophone, but others do not. Musicians benefit by knowing how to improve the music and the quality. Further research could explore the effects of pH values on the decibel.
A time trial cyclist uses most of his/her energy battling the effects of air resistance. Naturally, engineers have been fighting back with smooth bodysuits, the lightest bikes, and streamlined helmets. Recently, focus has shifted towards streamlined helmets, but most helmets have not yet implemented varying their textures. This experiment was designed to find the “leading edge” in helmet textures as well as expose a more efficient helmet shape. The independent variable is the helmet placed in the wind tunnel on a slider, and the dependent variable is the amount of wind resistance on the helmet. A force sensor is attached to the cart while a steady stream of wind is directed at the helmet. The helmets are small clay scale models, not full sized helmets. The shapes tested include a control helmet—smooth, teardrop shaped, with ear flaps—and three other helmets. These include a textured helmet and its smooth counterpart, and a helmet with no earflaps. The results showed that the control helmet was not the most effective shape, but neither was the textured helmet. The end result showed that the helmet with no earflaps was the most effective, presumably because the flaps acted as wind traps, effectively creating much more drag. This discovery could be further explored by experimenting on helmets with and without ear flaps, or even using vents behind the ear flaps.
Analysis of Photon-Mediated Entanglement Between Distinguishable Matter Qubits

Ari Dyckovsky
Heritage High School (HTH)
Academy of Science (AOS)

I theoretically evaluate establishing remote entanglement between distinguishable matter qubits through interference and detection of two emitted photons. The fidelity of the entanglement operation is analyzed as a function of the temporal and frequency mode-matching between the photons emitted from each quantum memory. With a general analysis, I define limits on the absolute magnitudes of temporal and frequency mode-mismatches in order to maintain entanglement fidelities greater than 99% with two-photon detection efficiencies greater than 90%. I apply my analysis to several selected systems of quantum memories. Results indicate that high fidelities may be achieved in each system using current experimental techniques, while maintaining acceptable rates of entanglement. Thus, it might be possible to use two-photon-mediated entanglement operations between distinguishable quantum memories to establish a network for quantum communication and distributed quantum computation.

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The Effect of Baseball Bat Temperature on the Performance of the Bat

Nicholas Fuhrmann
Heritage High School (HTH)

The effect of baseball bat temperature on the performance of the bat was examined. The alternative hypothesis was that if temperature increases, bat performance will increase. Baseballs were dropped 2.5 meters through a clear tube, impacting a bat at the bottom of the tube. The baseball’s rebound (dependent variable) was measured at 10.5, 19.0, and 29.9 degrees Celsius (independent variable). The control was the bat at 19.0 degrees Celsius. Quantitative data was collected and analyzed using ANOVA. The means for 10.5 C, 19.0 C, and 29.9 C were 59.8 cm, 65.7 cm, and 71.0 cm respectively. Though 0.06 probability showed an effect that proved the alternative hypothesis, at 0.05 probability the alternative hypothesis was disproved. An increase in temperature appeared to increase the performance, yet the results were not accurate enough to depict the size of the optimal location of impact. The lack of an efficient way to measure the rebound may have skewed results. Further research could answer questions concerning the variation of performance along the barrel of the bat with changes in temperature. In other words, does the optimum impact point move along the barrel of the bat with a change in temperature?

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The Effects of Varied Velocities on Blood Splatter Patterns

Zachary Harbour
Loudoun County High School (LCH)

The purpose of the experiment is to see if area of blood splatter increases in direct proportion to increase in velocity of a projectile. My hypothesis is that blood splatter would increase in size because of increase in velocity so you would be able to determine amount of force used to create the blood splatter. For the procedure a stand was assembled from pieces of wood to hold balloons filled with a combination of air and fake blood made from water, corn syrup and red food dye. Each balloon was filled with 20ml of fake blood and air to 51cm in diameter. They were held on the stand with a binder clip over a section of white bed sheet. Each balloon was shot with a BB gun from a distance of 2.9m and the blood splatter from the exploding balloon was absorbed by the sheet. The length and width of the splatter (crown droplet on left to crown droplet on right) was measured and recorded in a notebook. From those measurements the area of the blood splatter was determined. Each additional trial was done with an additional pump of the BB gun which increased the velocity of the BB. These trials were performed three times for each velocity level (1-15 pumps) and produced varied results. From the data recorded in my trials there were groups of data that were approximately the same area and showed little effects from the increased velocities. There were other individual trials that varied widely from the biggest area which did not occur at the greatest velocity to several times when the balloon failed to explode. The data in general would support my hypothesis but my overall conclusion was that the data is unreliable because the area does not consistently increase with velocity.

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The Effect of Classical Music on the Temperature of Water

Daniel Hellstrom
Broad Run High School (BRH)

This experiment was conducted in order to determine the effect of music on inorganic, non-living matter, water. The measure of the effect was reflected and tested in the temperature of the water. In past years, investigations pertaining to the effect of music on living creatures such as plants and animals have proved and in some instances, at least provided substantial evidence that music has a very strong psychological effect that can lead to a physical effect. The motive of this experiment was the determination to discover whether the effect of music could be purely physical in some cases; hence the choice to use water, a type of matter with no brain to think, listen, or respond. In this experiment, the music is the independent variable, the temperature of the water is the dependent variable, and the control group is the room temperature of the water that has not experienced the presence of classical music. In this study, classical music was shown to raise the temperature of water by about half a degree Celsius. In addition, the water did not proceed to cool down afterwards at the normal cooling rate of water. A T-test has proved the results to be valid up to 99.9%. Further research will be conducted in order to make the experiment more controlled by perhaps eliminating a human presence from the vicinity of the water and the music.

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The Effect of the Angle of Release on the Accuracy of a Lacrosse Shot

Conner Loving
Woodgrove High School (WHS)

The angle of a shooter’s release is thought to affect the accuracy of the shot. There are three angles to shoot from, overhand, sidearm, and underhand. The experiment is meant to show which angle is the most accurate for a lacrosse player to shoot. In the experiment, the shooter is ten yards from the center of the goal, and aiming at the top right corner of the goal. Overhand is the easiest way to shoot making it the control and the independent variable being the angle of release while the accuracy is the dependent variable. The average of the control group making the shot into the corner pocket is 38% while the sidearm is 26% accurate and the average for the underhand is 30% accurate. Based on the results, overhand or the control is the most accurate followed by underhand and then sidearm. The experimental data does support the hypothesis that the overhand shot or the control will be the most accurate. The independent variable did affect the dependent variable because when the angle of release was changed the accuracy was affected. Further research could explore the effect of the number of shooting strings in a stick and how it affects the accuracy. Also further research could explore if a mesh pocket or traditional stringing produces better accuracy.

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The Capacity of a Humans Vocal Sounds to Produce Electricity

Armaan Mehta
Freedom High School (FHS)

Gaining sufficient energy resources has been a prevailing issue for decades, and more so recently than ever. We, as humans, are approaching a point in time where it is unsafe, inefficient or difficult to continually use the methods of gathering energy we have thus far developed. Discussed here is the possible use of sound energy as a power source, its restrictions, and methods which can be used to overcome them. This experiment focuses on the plausible harnessing of the human voice in cell phones to aid in powering the phones themselves. Outputs of transducers were measured over a variety of frequencies and the different outputs were then mathematically tested for their ability to be collected as usable power. Different storage methods were considered including refined trickle charging as well as AC pulsation. Recently designed Charge Pumps, Step-up converters, and other converters were utilized in testing the capabilities of capturing sound energy. The recorded data showed efficiency rates lower than 0.01%, which is expected of sound energy. When a 95% efficient step up converter is applied, a power boost raising the wattage to standard cell phone power needs becomes possible. Further comparing techniques similar to these and their practical abilities leads to a strong basis for the future use of sound energy.

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The Effect of a Magnetic Field on the Rate of Water Flow

John Morrisroe
Broad Run High School (BRH)

Water has certain diamagnetic characteristics, meaning it slightly repels any magnetic field around it. The experiment was done by using a funnel, stood up by two wooden planks, a 1/4 inch tube coming out of the bottom of the funnel, silicone in a tube to seal the tube inside of the funnel, magnets attached around the tube for half of the trials, and 2 cups of water for each experiment. The water was poured into the funnel, with the tube sealed, and the time was started simultaneously as the tube was released. There was a significant difference between the time it took the water to travel through the tube with magnets than the tube without them. The reason the experiment was done was to help possibly reduce flow of water in dams and other water restricting items to better our energy production rates. This experiment was able to prove water's diamagnetic traits, and give a viable option to those who need water flow rates to be restricted on a fairly large scale. In the future, I would try different strengths of magnetic fields to see how much a very strong magnet can restrict water's flow compared to less forceful magnetic fields.

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The Effect of Various Temperatures on the Strength of Different Magnets' Magnetic Fields

Christine Olson
Park View High School (PVH)

The purpose of this experiment was to see if magnet strength changes based on temperature, allowing scientists to test magnets where they work best. The independent and dependent variables were the temperatures the magnets were exposed to and the magnets' strengths. After being exposed to room temperature (the control) and -12, 0, 100, and 200 degrees Celsius for an hour each, the magnets were placed on 100 steel ball bearings to see how many they could attract, then tested in room temperature again. The mean number of bearings attracted for each temperature was: room—73.84, -12—74.16, 0—73.2, 100—63.98, and 200 degrees Celsius—54.91, and room—72.26. A t-test was used and, with the P-value being P<.001, the results proved to be valid. The alternative hypothesis, "If magnets are exposed to room temperature, -12, 0, 100, and 200 degrees Celsius, then their magnetic strength will be most affected by their exposure to 200 degrees Celsius", was supported as the strength after being exposed to 200 degrees Celsius varied most from the control. When exposed to colder temperatures, the strength did not vary much from the control. In heat, the magnets weakened. A source of error was that after the magnets' exposure to 200 degrees Celsius, oven mitts were used, which could have interfered with the attraction of the bearings. Further research could indicate whether magnets work better when exposed to even colder temperatures.

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The Effect of Different Temperatures on the Strength of Optical Turbulence

Bhavya Ravigopal
Freedom High School (FHS)

The purpose of this experiment was to determine if temperature affected the strength of optical turbulence. Optical turbulence is caused by random fluctuations in the index of refraction of air arising from temperature, wind velocity, air pressure, and humidity changes in the atmosphere. Optical turbulence changes both the intensity and phase of the light that travels through it. The hypothesis was that when the temperature increases, the strength of optical turbulence does as well, thus producing higher scintillation index values. The hypothesis was tested by performing the experiment on a day that had a wide range of temperatures. A laser pointer was shone onto a power meter over some fixed distance. The collected values gathered every half second for a five minute interval were used to calculate the scintillation index, a statistical measure of how turbulent the air was. Then the measured scintillation index values were regressed against the corresponding measured air temperature values. It was found that air temperature is not a factor in optical turbulence along a horizontal path, so the hypothesis was rejected. Although, the results did correspond well qualitatively with a previously published measurement of optical turbulence as a function of the time of day. The significance of this experiment is to determine how environmental parameters affect the strength of optical turbulence. This could help in improving various laser and microwave communications and LIDAR devices to work more efficiently and provide better collected data for scientists who specifically depend on these types of instruments.

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The Relationship Between Where a Soccer Ball is Struck on Distance

Samantha Stafford
Stone Bridge High School (SBH)

One of the most important aspects of soccer is how the ball is struck, because it leads to goals and passes. This experiment tested the effect of where a ball was struck on distance the ball would travel. The independent variable in this experiment was the point of contact on the soccer ball, and the experimental groups were top right, middle right, bottom right, top middle, middle-middle, and bottom middle. The dependent variable was the distance the soccer ball traveled in meters. The control group was the ball struck on the middle-middle. A pendulum was made with a ladder and rope so a weighted ball could be held back and released to propel the soccer ball forward. The distance the ball rolled was marked and measured.

The means for the top right, middle right, bottom right, top middle, middle-middle, and bottom middle were 7.94 m, 10.31 m, 11.70 m, 8.34 m, 10.54 m, and 12.02 m. ANOVA and t-tests for each experimental group was performed, the alternative hypothesis was not supported, and the P-value was less than 0.05. Where the soccer ball was struck caused a change in the distance the ball traveled. When the ball was struck lower, the ball traveled higher, and was not slowed by contact with the ground, and when the ball was struck on the side, not all of the force from the pendulum made contact with the soccer ball. Further research could explore how one’s foot shape affects the spin of the ball.

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The Effect of Substitution and Vacancy Defect Arrangement on an Acoustic Metamaterial Structure Composed of Helmholtz Resonators

Peter Todoroff
Dominion High School (DMH)

The purpose of this research was to determine the impact of substitutional and vacancy defects in a metamaterial structure composed of Helmholtz resonators. Through measured spatial response and measured transmission loss behind different structures created using the resonators, how the substitution of defective resonators in place of active resonators impacted the structure’s resonance abilities was determined.

A three dimensional metamaterial structure increased in transmission loss and hence attenuated more efficiently as the number of unit cell rows in the structure increased. The decay length of the evanescent waves was reduced by addition of simple cubic unit cells into the metamaterial structure. The results indicate that the number of active resonators contributed significantly to the size of the effective modulus created by Helmholtz resonators and resonator geometry was insignificant. By utilizing the resonance properties of the resonators, transmission loss occurred in spectral gaps that peaked at the host material's resonant frequency.

Continued research regarding the inclusion of interstitial defects and analysis of different unit cell structures would further understanding of the impact of defects on metamaterial structures and phononic and sonic crystals. Research employing other forms of resonators is necessary and may affect the future of acoustical imaging in medicine and architecture.

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The Effect of Magnet Spacing on End Velocity in a Linear Accelerator

Daniel Vangorden
Loudoun Valley High School (LVH)

The purpose of this experiment was to determine how to get the greatest end speed out of the same magnets in a linear accelerator. The initial hypothesis was that the more space (and thus, time) the projectiles had to accelerate, the greater their end speed would be. Four tests were set up (at different times using the same magnets, to ensure consistency), consisting of a control, following instructions found online, and three other sequences which progressively increased distance between the five stages. These sequences were linear addition, the Fibonacci sequence, and a doubling sequence. They were arranged in that order from smallest to largest. However, when fired, the results directly and exactly contradicted the hypothesis: the smaller the track, the faster the end velocity, with the control fastest of all. Velocity was measured by placing a plastic block on the track and observing the distance it traveled when struck by the projectile. The control averaged 850 millimeters, the linear test 657 mm, the Fibonacci test 603 mm, and the doubling test 380 mm. A T-test confirmed that these differences were not down to random chance. The initial hypothesis was not supported, but a new hypothesis has been formulated to explain why. The spacers used in these tests, steel ball bearings, clearly absorb more force than was anticipated. Therefore, the larger tests, using more spacers, end up absorbing more force than they gain. It would certainly be interesting to investigate this hypothesis, or to investigate other, more efficient spacer materials.

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Investigating Supermassive Black Hole Binaries and the Stability of Lagrange Points L4 and L5 in the Restricted Three Body Problem

Katharine Xiao

Broad Run High School (BRH)
Academy of Science (AOS)

The purpose of this research project is to investigate the stability of particles at L4 and L5 in a supermassive black hole binary while varying the initial eccentricity, mass ratio, and semi-major axis of the black hole binary. If charged particles are able to remain in the system throughout the merging of the black holes, they would advance farther into the gravitational well of the black hole binary system. As a result, these particles could emit photons using their excess energy, and the resulting electromagnetic signals could be used along with gravitational wave detectors to locate these coalescing binary systems. This system is modeled using the restricted three body problem and Post-Newtonian terms. I wrote a C program that uses the fourth-order Runge-Kutta method and a variable step size to run simulations of the system. By looking at the test body orbits in a co-rotating frame, I was able to determine the critical eccentricity, the eccentricity at which the test body starts to become unstable, as a function of the system’s mass ratio for a constant semi-major axis. The critical eccentricity vs. mass ratio graphs for various semi-major axis values show prominent resonances which are compared to results from simulations implemented without Post-Newtonian effects.

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The Effect of Magnetized Water on Brassica rapa (Wisconsin Fast Plant)

Nathan Anderson
Loudoun County High School (LCH)

The amount and quality of available water is a significant factor in the growth and health of plants. The main procedure of this project was that two main groups of Brassica rapa plants, one watered with magnetized water and the other with tap water. The plants are kept in a sheltered container with a center light keeping the amount of light and the ambient temperature equal for both groups. The plants are consistently watered with 15 ml of the specific type of water each day. The type of water was manipulated and the overall growth of the plants measured. Magnetized water had the most positive effect on the plants with a significant difference using a T-test. Therefore, the hypothesis stating magnetized water will have no significant affect on plants growth is not supported by the data. A valuable endeavor would be to experiment how magnetized water effects other plants and in different types of climates. More trials should be conducted to verify that magnetized water really does affect the growth of plants. It would also be beneficial to see how magnetized water affects crop.

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An Evaluation of the Use of D-Amino Acid Oxidase in Determining Relative Age of Botanic Materials

Kevin Barnhart
Dominion High School (DMH)

Knowing the age of ancient fossils and materials has provided valuable insight into the history of life on Earth. The commonly used method of radiocarbon dating is popular yet its use has limitations. D-amino acid oxidase (DAAO), a ubiquitous enzyme found in living things, converts the stereoisometric D-form amino acids to their L-form partners, eventually reaching racemization. It may be that D-amino acid oxidase activity could be used as a versatile indication of age.

The purpose of this research was to determine whether D-amino acid oxidase (DAAO) activity in decaying plant matter decreased over time. Leaves from Prunus laurocerasus were homogenized and evaluated to determine enzyme activity over a nine day time period. Seventy percent of samples tested showed decreases in D-amino acid oxidase activity over the testing period. Remaining samples were considered anomalies due to inconsistent temperatures during reaction periods. Decreased activity of the enzyme can be used as an indication of slowing racemization and be used as an indicator of sample age.

It is often difficult to determine relative age of soft materials undergoing decay such as leaves, worms, and other organisms. Since D-amino acid oxidase is commonly found in organisms, determining activity may provide a method of relative dating for these materials. Further research would entail testing over a larger time period with greater diversity of materials in the test population. Globally, this is important because it can be used to date material that was previously unable to be dated using previous methods.

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The Effect of Corn and Onion Plants on a Tomato Plant’s Height

Lina Bhatti
 Broad Run High School (BRH)

The purpose of this experiment is to find out if plants can help another plant grow or stunt its growth. The independent variable of this experiment was the type of plant planted with the tomato plant. It was a corn plant and an onion plant. The dependent variable is the tomato plant’s height after it grows while being planted with the corn or onion plant. The control group is a tomato plant by itself. For this experiment, tomato, onion, and corn seeds are required. Plant a tomato seed alone, a tomato plant with an onion seed, and a tomato plant with a corn seed. Repeat this four times to ensure the reliability. Place plants under lights and water every day for 17-25 days. Measure on the last day. The means of the control was 41.4 cm, tomato with corn was 21 cm, and tomato with onion group was 62 cm. A t test was performed. The p value for the corn with tomato versus the onion with tomato is .001, onion with tomato versus the control group is .004, and the corn with tomato versus the control group is .005. In conclusion, the experimental hypothesis, if a corn and onion plant is planted with a tomato plant; the corn will negatively affect the height of the tomato, while the onion will positively affect the height, was accepted. The independent variable affected the dependent variable. This compares to the control because the corn with tomato group’s p value is greater than the p value of the onion with tomato versus the control group. A source of error could be that artificial grow lights affected the plants differently than natural sunlight. Further research could include if there are other plants that work well with tomatoes.

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The Growth Rate of Pumpkin Seeds Using Manure, Horse, Sheep, Chicken, Cow, a mix of all four, and potting soil.

Berenadette Boland
Loudoun Valley High School (LVH)

This experiment's purpose was to figure out which manure helps pumpkin seeds grow the best. The independent variable of this project was the different types of manure used (horse, sheep, chicken, cow, a mix of all four, and potting soil). The dependent variable was the growth rate of the pumpkin seeds. The control group was Sample F with no manure in it. The manure was collected and let set for five days. Then the seeds were planted, and watered every other day afterwards. For eighteen days, the growth of the seeds was examined. The data was collected and a T-test was run comparing each manure to the control. Sample A was, 0.717686; Sample B, 0.091721; Sample C did not have any growth due to the manure being too acidic; Sample D, 0.318932; and Sample E, 0.01822. The means for the groups are as follows: A, 18.41 cm.; B, 16.09 cm.; C, had no measurements; D, 20.57 cm.; E, 16.51 cm.; and F, 19.37 cm. All of these statistics show the growth rate between all six groups of plants. If pumpkin seeds are planted in six types of fertilizers, then the horse manure will cause it to grow the tallest. This hypothesis was not supported; instead, the cow manure and sheep manure tied for the tallest with a height of 22.86 cm. The manure and type of manure absolutely had an influence on how the plants grew based on the amount and types of nutrients in the manure. In the future it is possible to test varying amounts of cow manure to see if there is an optimal concentration. In addition, the manure could be chemically analyzed to see which aspect has the greatest effect.
The Effect of Almonds and Pecans on Venus Flytrap Health

Casey Borklund
Freedom High School (FHS)

Dianaea muscipula (Venus Flytrap) is a very unique plant that many people attempt to enjoy. Because of the plant's specific living environment and special dietary requirements, it can be difficult to keep them alive for a long period of time. Almonds and pecans were used as independent variables to determine the affect of fat content, as many owners feed the flytraps foods with too high fat, resulting in their deaths. To determine the fat content's affect, the plants overall health (mass, color) was recorded over ten days. The control group received no food supplement, only natural amounts of water and sunlight. Only three plants survived to be part of the experiment. The plant that was given almonds had a slight increase in mass and a decrease color. The plant that was given pecans had a slight decrease in mass and color. The control plant's mass and color stayed consistent. At the conclusion of the experiment, it was found that Venus Flytraps are incapable of successfully digesting these nuts, as the independent variable did not affect the dependent variable; however this was hard to determine due to a lack of repeated trials. Further research, with better technology, could explore the different types of fats that the plants are able to digest, and if that was a determining factor in this experiment's results.

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The Effect of Phosphorus and Nitrogen Percentages on the Growth and Oil Production of Botryococcus braunii Algae

Anna Broshkevitch
Loudoun Valley High School (LVH)

One of the more recent solutions for the problem of global warming and fossil fuel depletion is biodiesel derived from photosynthetic microalgae, which grows quickly in a variety of environments, including closed photo bioreactors, and have the potential to produce large quantities of oil. The ratio of phosphorus and nitrogen effects the growth and health of algae growing in it, as both nutrients make up various essential structures in plants. In the experiment, Botryococcus braunii algae was grown for twenty two days in a homemade photo bioreactor to find the ratio of phosphorus to nitrogen in fertilizer that the algae grew best in. The independent variable was the fertilizer, and the dependent variable the amount of growth (number of cells) experienced by a sample of the algae. After twenty two days, attempts were made to extract the oil from the cells. At the experiments end, fertilizer one (15% nitrogen, 30% phosphate) had a mean of 94.3 cells, fertilizer two (30% nitrogen, 10% phosphate) a mean of 21.3, and fertilizer three (36% nitrogen, 6% phosphate) a mean of 5.6. After the T-test, the null hypothesis that the ratio of phosphorus to nitrogen would not affect the growth of algae was rejected, and the hypothesis that the algae grown in fertilizer one was supported. Different methods were attempted, unsuccessfully, to extract the oil. The project could be expanded to test different algae species, methods of oil extraction, environmental conditions, or photobioreactor designs.

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The Effect of Nitrogen Levels on Rosette Size of Arabidopsis thaliana

Andrew Gutenson
Loudoun Valley High School (LVH)
Monroe Technology Center (MTC)

Mohammad Sabri
Broad Run High School (BRH)
Monroe Technology Center (MTC)

Arabidopsis thaliana is a model organism whose genome is greatly studied by scientists. It is of value because of its many benefits in research, including a small genome size, about 100Mbp of DNA, a fast growing cycle (five weeks) and easy seeding in a small space. Because Arabidopsis thaliana has been proven to survive cold and droughts, its genome has potentially significant agronomic value. The hypothesis of this experiment is that, if the amount of nitrogen (in the form of calcium nitrate) is increased in Arabidopsis thaliana, then the rosette size can potentially increase. Increased vegetative growth has implications for increased food productivity. Arabidopsis has potential as a food source or as a genetic influence in increase in crop yield. Four RILS (Recombinant Inbred Lines) from parent lines, Landsberg and Columbia, were seeded in groups of 25, 4 inch pots. The experimental group consisted of plants receiving a 200ppm solution of calcium nitrate while the control group consisted of plants irrigated by tap water only. Both groups received this treatment every other day via sub-irrigation to the pot tray. During the experiment, quantitative data was collected and recorded. On Day 27, measurements were taken of leaf surface area and each pot of plants was photographed. Initial data did not justify the hypothesis, so other statistical means of analysis will subsequently be used to confirm or deny this data. Leaf measurements will be analyzed by Photoshop CS5. By using Photoshop CS5, the leaves can be reduced to pixels, and pixels can be converted into physical measurement. If final data supports the hypothesis, then it is hoped that Arabidopsis may directly or indirectly have a significant impact on agronomic productivity, particularly in adverse environmental situations.

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The Effect of Soil with Different Optimum Levels in Nitrogen in Fertilizer on Pea Plant Biomass

Martyna Kot
Heritage High School (HTH)

The experiment's purpose was to examine the optimum level in nitrogen in fertilizer on pea plants. The independent variables were the soil types: sand- no nitrogen (control), soil with 10-10-10 (Nitrogen-Phosphorus-Potassium), and soil with 30-10-10. The dependent variable was biomass, which was measured in grams. Pea seeds were planted in the different types of fertilizer for 28 days. Fifteen cups were planted in no fertilizer, 15 in 10-10-10 fertilizer, and 15 in 30-10-10 fertilizer. After 28 days, the pea plant was cut, dried in a drying oven, and weighed on an analytical scale. ANoVA tests were run on the data. The means were: 3.3186g for the control, 4.0638g for the 10-10-10, and 5.0646g for the 30-10-10. The variance was: 0.77184559g for the control, 1.255303719g for the 10-10-10, and 7.60687E-30g for the 30-10-10. The standard deviation was: 3.56g for the control, 5.73g for the 10-10-10, and 5.31g for the 30-10-10. The t-value for the control vs. 10-10-10 was 4.761598027g, 8.696492983g for the 30-10-10 vs. the control, and 2.224980336g for the 10-10-10 vs. 30-10-10. The hypothesis was not supported by the data since it stated that the 30-10-10 will have the highest biomass. Therefore, a null hypothesis was established that states that there was no significant difference in the biomass between the three types of fertilizers. Future research could determine if the optimum level in nitrogen in fertilizer affects tomatoes.

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The Effect of Plastic-Mulch Color on Tomato Plant Fruit Production

Jessica Littman
Heritage High School (HTH)

Imagine finding a way to grow tomatoes in cool, northern climates as easily as in warm, southern climates. This experiment was conducted to research if mulch color could have an effect on fruit production. The independent variable was the mulch color (red or blue), the control group was brown wood-mulch, and the dependent variable was fruit production. Four different tomato plants were planted in each section of colored mulch. These plants were monitored, watered, and harvested as needed from May to September of 2011. Weight in kilograms of each collection was taken. The experimental hypothesis was “If red plastic-mulch is used, the plants will bear more fruit.” The raw data supported this, as the red plants produced 6.46 kilograms while the blue produced 5.59kg and the control produced 4.93kg. But the experimental hypothesis was not supported by the statistical data, which was determined from ANOVA testing. The mean for the control was 0.49kg the mean for the red mulch was 0.64kg, and the mean for the blue mulch was 0.56kg. But due to lack of trials, and a forced ending to the experiment by rain drowning the plants, the probability of this result assuming the null hypothesis was 0.78. If an experiment were to be conducted with all the same plants, more trials, a controlled environment, and a more controlled length, the effect mulch color has on fruit production would be more evident.

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The Effect of Newspaper Decomposition on Plant Growth

Charu Mishra
Broad Run High School (BRH)

Studies show that even though people recycle paper every day, more than 80% of the recycled newspaper finds its way to landfills and then makes up 38.2% of the total waste in landfills. In landfills, these biodegradable products don’t biodegrade, and in a landfill, two researchers, William Rathje and Wilson Hughes, found a newspaper from 1949 still intact during their study at the University of Arizona. This experiment has been conducted to figure out a way to dispose of old newspapers without them ending up in landfills. This experiment was done by taking 20 foam cups and planting a seed in each of them. Then, in half of the cups there were scraps of newspaper added. The dependent variable was the plant growth, and the control was the rest of the plants planted the normal way without newspaper. The mean height of plants without the newspaper added was 45.1; while, the mean height of plants with the newspaper added was 50.3. The experimental hypothesis was rejected by the statistics. Further research could explore what would have happened if the entire experiment had taken place in a better temperature controlled environment.

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Comparing American and Chinese Chestnut Trees to Their Third Backcross

Matthew Moon
Loudoun County High School (LCH)

The researcher’s experiment compared two chestnut tree species (American and Chinese) to the third backcross (repeated crossing to get desired genes from one species to another) of their hybrid by examining morphological characteristics of each population. American chestnut trees have been plagued with the “Chestnut Blight” since its arrival from Asia in 1904. The trees have been unable to grow successfully ever since. The Chinese chestnut was selected for hybridization because it is almost completely resistant to the blight. The researcher formulated the hypothesis “If certain morphological characteristics of American chestnut, Chinese chestnut, and its third backcross (B3) are measured, then the B3 will resemble more of the American chestnut.”

The experiment was tested as follows. First, samples were collected from chestnut orchards, totaling 75 American, 75 Chinese, and 150 B3 leaves (three leaves per tree). Measurements were taken for each characteristic (leaf length, width, surface area, pubescence, shape, margin serration size, and margin serration curvature). Length, width, and surface area were numerical data, and the others were “yes/no” type measurements. Finally, the data was statically analyzed using the 1-Way ANOVA test. It was determined that leaf length and surface area were significantly different among the three and the width was not. For further understanding, the averages and standard deviations were taken, concluding that the B3 was more similar to the American in the experiment. The result of this experiment supported the hypothesis and will hopefully benefit scientists in the process of reintroducing the American chestnut tree.

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The Effect of the pH Level of Water on Brassica rapa Growth

Laura Pax

Broad Run High School (BRH)

The purpose is to determine the water pH to facilitate the most growth in Brassica rapa (B. rapa) plants after 30 days. The independent variable was the pH of water given to the plants; dependent variable was plant height after the growth period. Four groups of 10 B. rapa seeds were planted and placed under grow lights. Each was watered twice daily with 10mL water of a specific pH. pH 6.0, 6.5, and 8.0 were tested, pH 7.0 was the control group. Each plant was measured daily and recorded as quantitative data. The mean height for the pH 6.0 group was 15.23 cm, 16.8 cm for pH 6.5, 13.2 cm for pH 8.0, and 16.1 cm for the control pH 7.0. The 6.5 pH group showed the highest mean height. T-tests compared each group to the others and to the control. A significant difference was found in t-tests on the 6.0 and 6.5 groups, the 6.5 and 8.0 groups, and the 7.0 and 8.0 groups, whose p-values were less than 0.05. The experimental hypothesis: if B. rapa plants are watered with pH 6.5, they will show more vertical growth after 30 days compared to those watered with pH 8.0. This hypothesis was supported by the data. The mean heights of the 6.5 and 8.0 were significantly different (P<0.05, P=0.01). The 6.5 pH water influenced the B. rapa height, shown in the t-tests on the 6.5 and the 8.0 pH groups and on the 6.5 and the 6.0 pH groups.

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Effect of wind on Lavandula angustifolia growth

Kevin Shao
Park View High School (PVH)

An experiment was conducted that advises where plants could be grown. This experiment tested how Lavandula angustifolia would grow under constant wind pressure. This was done by placing 5 plants under a fan with low speed, 5 plants under medium speed, 5 plants under high, and 5 plants without fans. They were taken care of and measured daily on their growth. The fan speeds were the independent variable. The plants with speeds were the dependent variable and the plants with no fan were the control. A ruler was used to measure the amount the plants grew. The means for each group were: low speed – 3.2mm, medium – 2.8mm, high – 2.2mm, and none – 4.2mm. A t-test was used to find what effect the wind had on the growth. A t-test is a statistical test for quantitative data and finds if it was significant. The experimental hypothesis, "If a Lavandula angustifolia is under constant pressure from a wind source then the plant will reach normal Lavandula angustifolia height." was rejected. The results showed that the wind pressure had a significant difference on the plant growth. The independent variable influenced the dependent very much. The groups with speed had lower average height than the control. A major source of error could have been how much sun was given to each plant. Further research could explore how wind affects other species of plants. The p-values for low, medium, and high were 0.3, 0.2, and 0.06. This means they are statistically different from the control.

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The Allelopathic Interaction Between Triticum aestivum and Secale cereal

Cara Skelton
Stone Bridge High School (SBH)

In allelopathy, one organism stimulates/inhibits growth of another organism by release of chemicals. It can be used for weed management to eliminate need for harmful herbicides or as a growth stimulant (fertilizer), to increase grain harvest.

The experiment evaluated the efficacy of allelopathic effect of Triticum aestivum and Secale cereal seeds on one another, in equal-compartment agar using delayed (sown 7 days after previously sown T. aestivum) and same time sowing methods. After 10 days shoot lengths (DV) were compared with controls (seeds sown separately).

All 4 T-test showed statistically significant difference (p<0.05) in heights of shoots in control and experimental groups except between T. aestivum (control) and T. aestivum in delayed sowing.

The ANOVA returns p<0.05 indicating significant difference in heights of control and experimental groups with the least height of T. aestivum in same time sowing and least height of S. cereal in delayed sowing.

S. cereal’s and T. aestivum’s growth gets inhibited significantly (p<0.05) in same time sowing in close proximity. In delayed sowing T-test for S. cereal (compared to control) showed significant difference, but did not show significant difference for T. aestivum, thus supporting the alternative hypothesis that T. aestivum will inhibit S. cereal’s ability to grow more than vice versa.

In delayed sowing, T. aestivum had 7 days to grow before S. cereal seeds were sown. The allelochemicals exuded from their roots into the agar affected S. cereal seeds negatively without a chance for them to sprout and release their own inhibiting allelochemicals. T. aestivum sown the same time as S. cereal becomes more sensitive to S. cereal’s allelochemicals.

Further studies can test various cereal grain crops for allelopathic potential, sensitivity, and possible application as a growth stimulant, or herbicide in weed management.

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Dendroclimatology in the Study of Snowfall’s Effect on the Rings of Deciduous Trees

Jackson Tettelbach
Potomac Falls High School (PFH)

Trees are some of the largest organisms on the earth and they can teach us many things including giving us records and predicting weather. The purpose of this experiment is to test how snowfall affects tree rings. To do this the independent variable is the amount of snowfall and the dependent variable is the size of the tree’s rings. The control group is the middle year of the three years chosen to be measured; it represents an average level of snowfall in a year. To do the experiment tree trunks were obtained and the years 2010, 2004, and 1973 were used and the rings measured in millimeters. The results were very interesting showing that the means were in 2010 lengths were 0.84 millimeters with 55 inches of snow, in 2004 it was 1.83 millimeters with 23 inches of snow, and in 1973 it was 2.57 millimeters with 7 inches of snow. This shows that the less snowfall there was the larger the rings were. The hypothesis was if more snow falls in a tree’s growth year then the tree’s rings in that year will be averagely bigger. This hypothesis was rejected with the exact opposite results other than one trail which had larger rings in 2004 than in 1973. This experiment could be better should experimenting should continue with more specific measuring and more tree specimens. It would also be very interesting what the results would be should coniferous tree’s be tested instead of deciduous.

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The Impact of Growing Method on Growth of Cilantro Plants

Caleb Vineyard
Loudoun Valley High School (LVH)

The purpose of this experiment was to determine what growing method produces the best results for plants that are sometimes grown indoors. Many herbs are grown indoors so Cilantro was used for this undertaking. Thirty two plants were set up with sixteen suspended over a large basin filled with a mix of water and nutrient solution. Deep in the bottom of the basin, an aquarium bubbler was attached to an air stone. The other sixteen plants were placed in containers filled with ordinary potting soil. The independent variable was the method in which Cilantro was grown, while the dependent variable was the height of the samples. Based on the numbers of the experiment, the plants grown in soil had a greater overall growth. But a handful of the hydroponically grown plants experienced extreme root mildew due to overwatering. The mean growth of the soil plants from day nine through seventeen was .73 centimeters while the hydroponics was - 0.5 centimeters. The roots of some samples grew too long and dipped into the water causing the mildew. The experimental hypothesis was that the hydroponically grown plants would grow taller than those grown in soil, and that hypothesis wasn’t supported because P > .05 was the outcome of the t-tests. The main problem experienced with this project was mildew of roots. Further research could explore the optimal height that the plants should be suspended from the surface level.

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The Effect of Salicylic Acid on P. vulgaris in Reversal of Abiotic Stress Caused by High Salinity

Adam Weiss
Stone Bridge High School (SBH)

Salinity decreases growth, defensive mechanism and productivity of plant. Enhancing stress tolerance in plants has major implications in agriculture and horticulture. The experiment evaluated if Salicylic Acid reduces the adverse effects of high salinity in P. vulgaris.

Group 1 plants received 15ml distilled water (positive control). Group 2 received 15ml 0.5mM SA (positive control). Group 3 received 15ml 100mM NaCl (negative control). Group 4 (experimental group) received 7.5mL 1mM SA (IV) and 7.5ml of 200mM NaCl.

The Average height (DV) for Group 1 was 33.1cm, Group 2 was 38.7cm, Group 3 was 25.73cm, Experimental group was 31.4cm. T-test shows statistically significant difference (P<0.05) in height of NaCl group and SA+NaCl group, with more height in SA+NaCl group, indicating beneficial effect of SA reducing salt stress. T-test did not show significant difference (P >0.05) in height of distilled water and SA+NaCl group, indicating SA reduced adverse effects of salt and maintained growth same as distilled water. ANOVA returns p<0.05, statistically significant difference in all 4 groups. The height is the least (most affected) in Group 3 (only NaCl). The height in SA+NaCl group is similar to the positive control, supporting alternative hypothesis.

Salt affects growth through osmotic inhibition of water uptake by root, loss of chloroplast activity, and decreased photosynthetic rate. Salicylic acid, similar to a plant growth factor, modulates plant responses to environmental stress by adjusting cellular metabolism.

Future experimentation can test effect of SA on germination and growth of seeds, while being exposed to salinity. The effect of different concentration of SA could be tested to find out which concentrations provide better stress tolerance. The effect of foliar salicylic acid applications can be explored by spraying plants under salt stress with SA and measuring the biomass of the plants.

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