Abstracts for the 33rd Annual
Loudoun County Regional Science & Engineering Fair

March 20, 2014
Tuscarora 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 X for individual project, T for a team project. The last numbers indicate the student’s grade.
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The Effect of Electromagnetic Fields on the Movement of Planaria

Melat Anteneh

A variety of organisms have been found to be able to detect and utilize magnetic and electromagnetic fields. This experiment was conducted to test the effect of electromagnetic fields on planaria. My hypothesis was that the planaria would be able to sense the electromagnetic fields and that the fields would affect their behavior and movement. The planaria were kept in separate cultures divided into four quadrants. Over the course of several trials, the movement of the planaria within the culture was observed and recorded while not influenced by electromagnetic fields and while surrounded by electromagnetic fields of varying intensity. For each set, there were ten trial periods and data was recorded twice a day every twelve hours. After the first set of trials, the p-values of three of the quadrants disproved the null hypothesis, but one did not. After conducting a second set of trials, all four p-values were below .05 and my hypothesis was supported. The strength of the field was also clearly a factor as to how well the planaria could detect the field. As for responding to it, the planaria swam in a clockwise direction, following the electromagnetic current, evidenced by the fact that the most populous quadrant always rotated in the same direction. When I reversed the field, the planaria changed course and swam in accordance to the new direction. This project could be expanded upon to test how strong the field must be in order for the planaria to be able to detect it.

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Ship Collisions or Fishing Gear Entanglements: Which Is More Deadly to Whales?

Carolina Chung
Robin Duke

This study was conducted in order to analyze the effectiveness of the action taken by the government within the past few decades concerning environment protection through regulations on fishing and ship travel. The question being tested, then, was if there has been a change in the survivability rate of Northern Right Whales regarding ship collisions and fishing gear entanglements over the past four decades. The data that was used in this study was pulled from various online sources, such as the “National Oceanic and Atmospheric Administration” and the “Northeast Fisheries Science Center.” While the ship collisions and fishing gear entanglements with Whales served as the independent variables, the dependent variables were the survivability rate of whales when involved in ship collisions and fishing gear entanglements. The data acquired was put into a program called the Analysis of Variance (ANOVA), which interpreted the information through statistical hypothesis testing. This form of test involves P-values, which help to determine if the null hypothesis can be rejected or not. For this study, two P-values, which were greater than 0.05, were acquired for the correlation between survivability rate of whales in ship collisions and fishing gear entanglements. This, then, led to the accepting of the null hypothesis, which stated that there is no relationship between the independent and dependent variables. In conclusion, there was a lack of effectiveness in the execution of government policies regarding the protection of marine life, and therefore there needs to be greater emphasis on effective execution of policies that are implemented in order to promote the conservation of Northern Right whales.


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The Effect of Changing the Components of Compost Given to Eisenia fetida on the pH Level of the Soil it Enriches

Jennifer Crawford

Earthworms have the potential to reduce at least 75% of harmful landfill composition and can help improve the environment’s health and appearance with the cooperation of humans. The independent variable, the type of food scraps given to Eisenia fetida, can determine whether the pH of soil, the dependent variable, will become more or less acidic. Compost without fruits, vegetables, or shells is the control, and the constants are the type of worms, the containers, and the type of soil, as well as many other factors in the experiment. After composting for two months, the results determined that the type of food scraps added to compost affect worms’ castings, therefore affecting the pH of the soil. The mean for compost without added components was 7.0 pH, and the mean for compost with orange peels and potato skins was 6.33 pH. The mean for the compost with eggshells and uncooked pasta was 7.366666667 pH. The means of the experimental groups were significantly different with a P<0.05. The alternative hypothesis, if fruit peels and vegetable skins are given to Eisenia fetida (red wiggler earthworms) rather than eggshells and uncooked pasta for two months, then the pH level of the soil will become less acidic and more alkaline, was supported. The components of compost affected the diet of Eisenia fetida, thus changing the pH of their excrements, causing a change in the pH of soil. Further research could explore how scraps of other food groups can cause an effect in the pH of soil.


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A New App(roach) to Pest Control

Andrew Dinh

The fungus Beauveria bassiana is a known biological insecticide. While B. bassiana is advantageous because it only targets specific organisms, it is disadvantageous in that it requires certain conditions as it is a living organism. On the other hand, pyrethroids, a class of chemical used in virtually every pesticide worldwide can be used in a much wider range of conditions but can cause significant damage to the environment. Therefore, the aim of this research is to determine whether these two agents have synergy when used in conjunction with each other. Cypermethrin, permethrin, and allethrin were the pyrethroids tested. Positive control trials were conducted to test the efficacy of these pyrethroids on Blaptica dubia, and it was shown that these chemicals resulted in nearly 100% mortality in roaches after three days. Mortality trials were conducted at concentrations from 150 mg/500 ml methanol to 75 mg/500 mL, with intervals of 15 mg/500mL. Synergistic trials were conducted with the same concentrations of pyrethroid combined with a constant amount of B. bassiana and efficacy was compared to the pure chemical trials. Ideal results could yield an equally effective but less environmental damaging pesticide for potential future commercial use.


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How Does the Species of Earthworm Affect the Level of pH and Amount of Nitrates in the Soil?

Caitlin Dumm

A rising environmental issue in the Great Lakes region of the United States concerns invasive earthworm species and their harmful effects on the lush forest floor. The goal of this study was to discern the type of earthworm: Eisenia fetida or Eisenia hortensis, which would have the greatest, negative effects on the environment, so that it could be monitored and prevented from entering the forest. In the experiment, the pH and nitrate levels of the soil (the dependent variables) for each of the species of earthworms (the independent variables) were recorded and compared over time, also with a control group containing no earthworms, to determine which species had the greater impact on the chemistry of their environment (constant). The mean for the Eisenia fetida species compared to the Eisenia hortensis species was 6.4 to 5.9 on the pH scale, respectively. The control group’s mean was 5.9. The results from the t-test were not statistically significant (p>0.05 for the Eisenia fetida species and the control group) and minimally significant (p<0.0 for the Eisenia hortensis species). The alternative hypothesis stating that the Eisenia hortensis species would increase the level of pH in the soil by a larger amount than the Eisenia fetida species was rejected. The independent variable didn’t cause a change in the dependent variable, because the two species’ were not anatomically different enough, and the starting levels of pH differed. Further research could explore more types of earthworms, and their effect on ecological factors other than pH and nitrate levels.


Shark Attack Statistics

Colton Fambro

The U.S is home to more than 50% of the world’s shark attacks. 61 of the 118 shark attacks have occurred in the U.S. Statistically, one is more likely to get attacked by a shark while swimming or surfing rather than wading or fishing. The topic that is being researched is: The various aquatic activities that make humans more susceptible to shark attacks. With this experiment, the activities that were evaluated were: spear fishing, surfing, swimming, paddle boarding, fishing, diving, snorkeling, wading, boogie boarding, body boarding, and kite boarding. The hypothesis is: If a person is swimming or surfing, then they are more likely to be attacked by a shark. With all the statistics, it was discovered that the boarding and swimming groups were the groups with the highest number of shark attacks. There is no significant difference between “boarding vs. swimming” which has a p value greater than 0.05 using the ANOVA program. Where the p value of the data is less than 0.0001, which means the data is extremely significant between “boarding vs. fishing”, and “fishing vs. swimming” using ANOVA program. In conclusion the major groups “swimming” and “boarding” are the leading activities of shark attacks. While doing activities in these groups, you are more likely to be attacked by a shark. Over a period of eight years, “swimming” and “boarding” groups have had a larger number of attacks compared to that of the “fishing” group. These results were based off ANOVA, and resulted in supporting the hypothesis. One is more likely to get attacked while swimming or surfing rather than any other ocean activity such as wading or fishing.


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Effect of parasites on crickets

Hannah Ford
Monica Munoz Amaya

Crickets have been known to drown themselves in water, and the purpose of the experiment was to see if parasites were the cause of this behavior. The independent variable of the experiment was the parasites and the dependent variable was the number of crickets that drowned. The control group was the group of crickets that did not drink the water infected with parasites. Together there were twenty five trials for the crickets with nematode parasites and the crickets without nematode parasites, each trial contained ten live crickets. The alternative hypothesis was if Acheta domesticus (cricket) drinks water infected with a Caenorhabditis elegans (nematode), the crickets will change their actions. The mean for the group with parasites was 0.7143 dead crickets, and the mean for crickets without parasites was 0.3929 dead crickets. The independent variable, the presence of C. elegans, did not influence the dependent variable, the behavior of the crickets, to a significant amount. A t test was performed and the p value was 0.0792. With the p value being more than 0.05, the null hypothesis was accepted. Error resulted because the crickets would eat each other, and the parasites were not visible so it was challenging to transfer them in the crickets’ water gel. Further research could see if parasites had any effect on crickets that were alone in a cage rather than crickets being together. Also parasite effect on other things like animals or humans could be examined.


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Osprey (Pandion haliaetus carolinensis) Migrational Dependency on Sea Surface Temperature and Magnetic Field Variation

Daniel Hoerauf

Every year, thousands of migratory birds travel from their homes in colder climates to winter in areas with more abundant supplies of warmth and food. Osprey (Pandion haliaetus carolinenses) are one such migratory species, traveling between the Eastern coast of North America and the Northern coast of South America. With increasing shifts in today’s climate, such birds might have to adapt, adjusting their flyways and migratory phenology. If flyways shift, devastating effects could occur in ecosystems. Birds may be introduced as new predator or prey species or they may remove themselves as a predator or food source. Two such environmental sources of these changes are sea surface temperatures, guiding migratory birds along the path of prey and warmer air and geomagnetic intensity which provides the birds with a natural compass for long migrations.

Migratory flyways of ospreys were analyzed with regards to sea surface temperatures and geomagnetic field intensity from September to November migrations during 2007 – 2012. Statistical analysis via t-tests indicated there was a significant difference between the percentage of birds using flyways of high versus low sea surface temperatures and high versus low magnetic field intensity, with the birds primarily preferring to migrate along flyways of lower sea surface temperature and higher magnetic field intensity. Further research would determine the effects of these changes in additional species of birds to see whether these migratory tendencies are isolated towards a particular species or just predatory birds. This would assist in the monitoring of the population statistics of birds.


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The Effect of Temperature °C on Daphnia magna Heart Rate B/M

Valerie Knowles

The purpose of this experiment was to determine the effect of temperature on the heart rate of Daphnia magna. The dependent variable was the heart rate of the Daphnia magna. The independent variable was the temperature of the water. The control was the temperature 21°C. There were four experimental groups with fifty Daphnia magna in each. A container of Daphnia magna was placed in 18°C water. After five minutes, the Daphnia magna were taken out and their heart beats per minute were counted under a microscope. The Daphnia were put in the next temperature for all temperatures: 15°C, 21°C, 24°C, and 27°C. An ANOVA test was done. The mean for the heart beat per minute (B/M) of the Daphnia magna in the temperature 15°C was 164.8 B/M, at 18°C was 202.8 B/M, at 21°C (the control) was 221.92 B/M, at 24°C was 245.44 B/M, at 27°C was 298.42 B/M. The alternative hypothesis, if the temperature is raised, then the Daphnia magna’s heart rate will increase, was supported. The p value was less than 0.0001. The temperature of the water did affect the Daphnia magna’s heart rate. Error resulted when the Daphnia magna did not have the same amount of time in each temperature. Future experiments should use a modern microscope and a greater number of Daphnia magna. Different types of Daphnia should be used to see if temperature would have the same effect. After completing this experiment, the question, does sunlight affect the heart rate of Daphnia magna was raised.


Ebert, D. n.d.. Ecology, Epidemiology, and Evolution of Parasitism in Daphnia. Bethesda MD, US.


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Acids vs. Bases: Clams

Lindsey Long

This experiment is trying to find freshwater clams' tolerance level to acids and bases. In this experiment, the independent variable is the pH of the water the clams were in. The dependent variable is how long the clams lived and the collective number of dead clams at the end of the experiment. The control group is the clams in the natural pond water. To perform this experiment, 30 clams were placed in acidic, basic and natural pond water for two weeks. During these two weeks, the clams were checked on and fed, counted, and the dead were disposed of every two days. The data supported that clams had a lower tolerance to acids than bases. The means for acidic water, natural water, and basic water were 23.5, 0, and 0.8571 dead clams, respectively. The experiment collected quantitative interval data and the statistics were done doing an ANOVA. The alternative hypothesis, if clams are put into acidic, natural, and basic pond water then the clams in the natural water will last the longest, was supported. With a p value of less than 0.0001, the results show statistical significance. The independent variable, the pH of the water, affected the survival of the clams. The acid was not consistently measured which may have led to problems later on. To take this experiment further, more clams or any other organism should be tested with different acids and bases to find an average for their tolerance level.


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Are Overweight Bow-legged Canines More Prone to Getting a Clinical Medial Luxating Patella?

Chasity Maupin

Clinical medial luxating patella (CLMP) is one of the most common issues found in overweight bow legged canines. If a canine who is predisposed to a bow-legged confirmation is overweight then they are more likely to have CLMP. The purpose of this experiment is to investigate if overweight canines who have a bow legged confirmation are more prone in developing CLMP. Therefore, these canines need to maintain an ideal weight to help put less stress on their knee caps. Then, they will less likely develop this condition. The experiment was to determine if bow legged canines having undergone surgery for CLMP are more prone to being overweight. Ninety canines from thirty nine different breeds were used in this study. The dependent variable was the amount that each canine’s weight differed from the AKC’s average weight for that breed. The data collected and recorded included the breed of canine, the average weight of each specific breed, the actual weight of the canine, and the weight comparison. The weight comparison is used to determine if the canine is overweight or at ideal weight. An average weight for a Chihuahua is 5lb (2.2kg). However, one Chihuahua in this study weighed 15lb (6.8kg). Therefore, that Chihuahua was 10lb (4.5kg) or 200% overweight. The results in this experiment concluded that 87% of the canines, who developed clinical CLMP, were overweight. On the other hand, 13% of the canines were at ideal weight. The hypothesis being tested was validated by this experiment.


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The Effect of Raid on solenoponsis formicide

Heather Mosesso
Jasmin Nair

The problem is to test different concentrations of Raid, known for terminating solenoponsis formicide. The independent variable is diluted Raid. The dependent variable is amount of sprays it takes to kill the Solenoponsis Formicide. The control group is fully concentrated Raid. Solenoponsis formicide was used because Raid repels them. The procedure is spraying diluted Raid and fully concentrated Raid on Solenoponsis formicide. This shows whether diluted Raid works as well as fully concentrated Raid. A important finding is the results showing fully concentrated Raid works better than diluted Raid. Fewer sprays were needed when using the bottle of fully concentrated Raid. The mean is 4.59 sprays for diluted Raid and 0.73 for fully concentrated Raid. The results t equaled 17.5871. P was less than 0.05. The supported alternative hypothesis is if Raid is diluted, then it will not work as effectively as fully concentrated Raid. The statistical data showed diluted Raid needs four times the sprays than fully concentrated Raid. The independent variable affects the dependent variable because it showed it required more sprays than fully concentrated Raid. Error is the condition of the solenoponsis formicide. Some could alter in health due to the environment. A lot of Solenoponsis formicide died before the experiment, this affected the outcome of data. A question for research is if a different species of solenoponsis formicide would vary the results.


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Enhancement of Associative Learning in Zebra Fish via Vitamin B12 Nori Food Supplements

Stacy Spitzer

Alzheimer's disease causes shrinkage in many areas of the human brain, primarily the hippocampus which controls encoding, storage, and retrieval of memories. Vitamin B12 is believed to have positive effects on memory-making. Because associative learning by creating a relationship between multiple unrelated items or ideas may be connected to memories, exposure to Vitamin B12 may enhance this type of learning. The purpose of this research was to determine whether Vitamin B12 would enhance associative learning in zebra fish. Hence, it may also improve hippocampus function. To test learning, ten zebra fish were divided into two tanks of five fish each. One tank served as a control while the other served as an experimental tank. For ten days, a red light was placed in the corner of each tank for five seconds while food was provided. The speed at which fish remembered food location over time was recorded. Statistical analysis via a t-test indicated significant difference between the velocities of the experimental fish and the control fish. Each experimental fish increased the velocity at which it found food compared to its velocity at day 1. The average change in velocity for the control fish was close to zero. Hence, it was concluded that Vitamin B12 in the Nori seaweed food improved memory connected to associative learning. This increased quickness at which fish found food. Further research would entail exploring the use of Vitamin B12 in other species with the hopes of improving memory retrieval in Alzheimer's patients.


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The Effect of Bisphenol-A (BPA) on Reproductive Success of Drosophila melanogaster

Justin Virts

BPA is an epoxy resin found in many plastics, and has been shown to affect estrogen related receptors (ERR's) and possibly cause infertility, and affect development of liver, prostate, and brain. This experiment was designed to test the effect of BPA on reproductive ability of Drosophila melanogaster by comparing the number of offspring per generation from BPA exposed fly populations to the unexposed control populations.

Ten colonies of twenty flies each were assorted and gender typed. Five populations were fed untreated liquid fly medium and five fed medium mixed with BPA so the chemical could be consumed. The data collected gave an average of 18.2 offspring per female for the control and 1.41 offspring per female for the BPA populations. A one tailed t-test gave a t value of 4.72 and a p value of .0015 which shows the data to be statistically significant and supports the experimental hypothesis that BPA causes decreases in viable offspring in Drosophila melanogaster populations with 95% confidence. This decrease was due to the BPA inhibiting DNA transcriptions that control developmental transitions from egg to larvae and then larvae to pupae.

Knowing that the hypothesis was supported in this experiment opens up the doors to an endless amount of studies; the most appealing being studies of the effects of BPA in humans. It is possible to test BPA levels in humans through urine, so looking for connections between locations with the highest BPA levels in humans and the most common health issues in the areas could link BPA directly to these health problems.

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How Does Knowing the Missing Ingredients Affect the Perception of Flavor?

Georgina Atkinson

Having a food allergy is difficult, especially when diet altering substitutions occur. In cases there is an obvious flavor difference between original items and substitutes but more often, the only difference is missing ingredients. This experiment was to discover how knowing what ingredient was missing affected participants’ perception of flavor. Each participant was asked to sample two different chocolate cupcakes and score their flavor using a scale of 1 (worse) - 5 (best). One cupcake contained typical ingredients. The other contained a dairy substitute. This experiment included three groups: Control, 1, and 2. Culinary placebo effect was used on group 1, group 2 was told the truth, and the control group compared the cupcakes without knowing which one was dairy free. Group 1 gave cupcake A a score of 2.6 and B a score of 1.9. Cupcake A received a 2.6 from group 2, while B got a 3.4. The control group decided cupcake A was dairy free and gave it a 2.5. Cupcake B was marked as containing regular ingredients and received a 3.6. A t-test combined p-value for group 1 was 0.003688. The combined p-value for group 2 was 0.00309. This showed that overall, there was a significant difference in the data and it was not just by chance because both p-values were less than 0.05 and less than 0.01. As hypothesized, the cupcake that was believed to be dairy free received much lower scores than the regular cupcakes. This shows that the perception of flavor can easily be swayed by information given about the food. It would be interesting to do this experiment again, but with only one type of cupcake to verify results. Also, different recipes could affect the outcome.

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The Effect of Enjoyment on Time Perception

Danielle Elenita Borgonia

Many students claim that time seems to go slowly during a boring lecture and fast during lunch. This experiment was to determine if the amount of enjoyment does have an effect in the perception of time. In order to find out, 30 participants were asked to perform several activities and guess the amount of time they think has passed while performing each activity. They were then asked to rate each activity from least enjoyable to the most enjoyable. The activities include: sitting, talking, watching a video, reading, and drawing. The control group was the “sitting” activity. The ANOVA, with a P-value of a 0.51, show that there is no connection between the level of enjoyment and perceived time. Due to the high P-value, the alternate hypothesis, if the enjoyment level of an activity increases, then the difference in perceived time and actual time will increase, is not supported and the null hypothesis must be accepted. This conclusion shows that time should not feel like it “flies by,” as many claim, while having fun and slow down while being bored. Further research might include lengthening the time given (120 seconds) to a greater amount. Adding more activities would also help further understand the link between enjoyment and time perception. Tests should also be done testing the amount of stimulus being processed, as stated by other scientists would have an effect on perception.

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The Comparison of Gender on Accuracy of Eyewitness Account

Bezawit Delelegn
Neha Gupta

Every day thousands of crimes occur that requires society to follow up with details. One widespread form of obtaining verification of a crime is the use of eyewitness account. The purpose of this study was to find which gender is more accurate at pinpointing details of an event, which may prove to be vital to a conviction. The independent variable was the gender of each subject; the dependent variable was the accurate identification of a subject during an event. The subjects were males and females between the ages of 14-18. The experiment included presenting a video to participants. The participants were then given surveys to respond to that required listing the subject’s gender and making an identification of the suspect described from the video. The median of the results was zero. The correct identification was suspect twelve, however the mode response was option seven. The original hypothesis that more females would answer correctly rather than males was supported as a total of six females answered correctly in comparison to five males. This result supports that females are more accurate in recovering details. A Chi-square test was done providing the result of, c2(1, N = 65) = 0.08, p = 0.05 and therefore accepting the null hypothesis of no significant difference between genders correctly identifying suspects during a crime. Other variables to test could include how each gender handles difficult situations or rational thinking during events.


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The Effect of Gender on Frustration

Camryn Fischer

Fifty 8th grade middle school students (27 females and 23 males) were asked to replicate a paperclip pattern onto an electromagnetic grid within a 90 second time frame in order to determine whether there is a significant difference in frustration levels based on gender. While the experiment was underway, the researcher remained hidden behind a trifold board and switched that magnetism of several of the grid pieces on and off by changing the polarity of their electromagnets as a means to control the difficulty of the task. This manipulated factor was instrumental in causing the student volunteer to become frustrated with his/her inability to complete the task. The researcher made qualitative observations of the volunteers while completing the task and also asked each one to rate his/her level of frustration on a scale of one (very calm) to ten (very frustrated). A t-Test was performed on the volunteers’ frustration ratings with alpha equal to 0.05 and df equal to 48, where p is less than 0.144671821, indicating no significant difference between the frustration levels of the males and females when faced with this particular task. Qualitative data, however, showed that the male test subjects seemed to seek more alternative methods for completing the task, like bending the paperclips, while female test subjects were more inclined to ask questions after completing the task. An extension of this study could involve comparing responses involving memory or logical reasoning between genders or comparing different age classes’ responses between genders when assigned identical tasks.


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The Effect of Gender on the Stroop Effect

Samantha Gertig
Adriana Guillen Santalla

The Stroop Effect is a psychological experiment, testing the efficiency of the brain on how fast and how correct someone can read a series of words written in a color, but that word says another color. In this particular experiment, the independent variable is the gender, 25 males and 25 females. The dependent variable is the amount of time taken to complete as well as the number of hesitations/mistakes made. The control group in this experiment is the amount of time taken and the amount of hesitations/mistakes made by the scientists composing the experiment. Each subject was told to read the color of the word all the way through the paper as they were timed and mistakes were counted. The mean for the time taken for females was 10.58 seconds and the mean for the males was 11.458 seconds. The mean for hesitations was 2.84 for females and 4.0 for males. A t test was performed and the p value was 0.2028 for hesitations and 0.1250 for time. Statistically, this was not significant. The alternative hypothesis, if 25 males and 25 females are tested on the Stroop Effect, then females will have a faster completion time and fewer mistakes, was supported. The data shows that females, overall, did better than males and also that the independent variable effected the dependent variable. Further research on this experiment would be to test more people, in a calmer, quieter environment, and to test only one age, for example, only testing teenagers.


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Environmental Inhibition/Maximization of Creativity in Individuals of Varying Brain Dominance

Heather Green

It has long been suggested that the brain's hemispheres control certain thinking styles. Specifically, the right hemisphere is responsible for creativity and artistic ability while the left hemisphere is responsible for logical thinking. Therefore, individuals with left brain dominance naturally think more logically while right brain dominant individuals tend to think more creatively. The purpose of this research was to determine whether environmental conditions played a role in the success experienced by right and left brained individuals when taking tests that assessed creativity.

Participants took four versions of a remote associates test under the following conditions: six minute time limit with silence, six minute time limit with background noise, unlimited time with silence, and unlimited time with background noise. Statistical analysis via t-tests indicated that left brain dominant individuals performed significantly better than right brain dominant individuals when placed in three environments: six minute time limit with background noise, unlimited time with background noise, and the unlimited time with silence. Ultimately the presence of background noise as well as time limitations when testing had a greater detrimental effect upon right brain dominant individuals, as they were not as successful on the tests as were left brain dominant individuals. This knowledge is imperative because creativity could be maximized by determining brain dominance in individuals and the type of environment needed in order to maximize success whether in an academic setting, employee setting, or personal setting.


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The Use of Symbols as Placebos in Increasing Cognitive Performance

Brittany Hayes

There is little known about the extent of the placebo effect. The general definition of the placebo effect is the improvement of an individual's condition through a faux treatment. The placebo effect is primarily seen in the medical field, however, it has been theorized that this effect occurs in the sociological field as well.

The purpose of this research was to determine whether or not symbols could be classified as placebos. Individuals were tested to determine the time it took to complete four jigsaw puzzles. The first two puzzles were completed in a controlled environment in order to establish a baseline to compare the time lost or gained in puzzle completion after exposure to both random symbols and symbols that were connected to each individual's personality as determined by survey.

T-test results showed an insignificant difference; however, on average the individuals exposed to random symbols lost more time than individuals exposed to those connected to their personalities. Further research should be conducted to determine whether or not the power of the memories associated with the personal symbols was enough to distract those participants. This is interesting because even though the participants did not look directly at the symbols during the study, individuals mainly gained time as opposed to individuals with random symbols. Further research could demonstrate why this occurred and then allow scientists harness this information to increase productivity in every day settings.


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The Effect of Lavender on A Person's Memory

Amy Hensler

In this experiment, it was tested to see if lavender would affect a person’s memory. This experiment focuses on the brain and how smelling something (lavender) can affect how someone remembers particular information. This was done by gathering 50 subjects and having them complete two tests. The first test was the control test, which was a simple memory test, to use this to compare to the test with lavender. Subjects had five minutes to study and complete the test. After they completed this, they took another simple memory test but while smelling lavender to see what effect it had on the subjects. The independent variable was the lavender and the dependent variable was the number of answers correct on the test. A quantitative t test was performed to determine statistical significance. The results of this test were that lavender had little effect on how a person remembered something, due to the low number of trials. The mean for the control test was 9.06 answers correct while the mean for the lavender test was 9.56 answers correct. The alternative hypothesis for this experiment was if subjects take a test while smelling lavender, then the subjects will remember more than when they are not smelling the lavender. The alternative hypothesis was rejected because the p value was greater than 0.05. One error in this test was measuring the distance the lavender was smelt from. Further research of this topic can include testing what types of smells are more effective in helping memory.


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Using Twitter to Predict the Outcome of VA Gubernatorial Election

Caroline Holmberg

The advancement and growing popularity of social media has become a large part of American citizens’ everyday life. One specific social media website, Twitter, lets users post a 140-character status update called a “tweet” as often as desired. These “tweets” contain the uncensored thoughts of millions of users, allowing Twitter to become a useful tool in gauging the public opinion on various issues or policies.

The purpose of this research was to determine the predictive nature of Twitter in the 2013 Virginia gubernatorial election. Tweets containing the keywords “Cuccinelli” or “McAuliffe” (the leading Republican and Democrat nominees, respectively) were collected at random and analyzed two ways: through a count of keywords and through analysis of context. The analysis through count of keywords found more tweets mentioning McAuliffe than Cuccinelli in the given time period. The context analysis resulted in more positive tweets for Cuccinelli than McAuliffe. These results indicate that more people were talking about McAuliffe, regardless of positive or negative context. Further research would entail analysis of the tweets through context analysis and syntax analysis programs. Ultimately, as indicated by the number of tweets, McAuliffe was the winner of the gubernatorial election for Virginia.


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The Effect of The Golden Ratio “Phi” on What the Human Brain Finds Aesthetically Pleasing About People, Plants, and Animals

Meghan Kammerdeiner

The purpose of this research project to support whether or not The Golden Ratio plays a significant difference is what human beings find naturally more attractive. The Golden Ratio is a proportion known as “Phi” that is approximately equal to 1.618. The theory behind The Golden Ratio is a line divided into two so that the longer part divided by the smaller part is equal to the whole line divided by the longer part. In nature no one and no thing has ever had this exact divine proportion. However, those, which have proportions closest to 1.618, are seen as more pleasing to the human brain. The Golden Ratio can be found in Animals, Humans, Building, Plants, Art, and Anatomy. In my experiment I tested how significant The Golden Ratio was when compared between images of people, animals, and plants. Pairs of pictures to a class (ages 15-16) on a PowerPoint and each student choose which picture they found the most attractive from each pair. The results supported the significance The Golden Ratio has on what the human brain finds naturally appealing. This research is important because it can be used in many business fields, for example marketing. These results can support whether it is more for the marketer to use people, plants, or animals, which have positive measure of The Golden Ratio to attract the human subconsciously to their ad. The importance of this Science Research Project is to use The Golden Ratio proportion 1.618 to support a more tangible understanding of the psychology behind what the human brain finds aesthetically pleasing.


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What Do You Recall?

Laura Karcich

The purpose of this experiment is to see if gender type has any effect on expressing the Primacy Effect. This psychological test is on the Primacy Effect, the increased ability to remember items from the beginning of a list. Gender type is the independent variable; females are the control group, males are the experimental group. The average percentage of a group test result to express the Primacy Effect is the dependent variable. Test subjects are ages 15 to 18, twenty-five females and twenty-five males (of any ethnicity). These volunteers were read a list of words then asked to do a distraction. After, the subjects wrote down words that they remembered from the list. This was done a series of five times. The means were 44% for females and 36% for males. The alternative hypothesis; if separate groups of female and male test subjects are read a list of household items, then the females will have a higher percentage of recall (Primacy Effect) than males, was not supported. The P-value (0.9099) is greater than 0.05, the null hypothesis was accepted. The independent variable did affect the dependent variable, but was not statistically significant. An error affecting this experiment was test subjects not being tested at all at the same time. Further research questions are: Does age affect the Primacy Effect averages? Does the amount of words given to recall affect the words remembered from the Primacy Effect?


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Divided States of America: Modeling Partisanship in Congress

Santiago Munevar

On October 1st, 2013, the United States Government shutdown during a divisive battle over the Affordable Care Act. Two weeks later, 800,000 federal workers returned to their jobs, but the problem of partisanship has all but disappeared. Social scientists have postulated that congressional redistricting, political culture, and campaign finance have all been instrumental in the partisan schism. Currently, most of these effects are studied using DW-NOMINATE, a statistical model that measures a congressman’s ideology. Although ideology can be used a measure of bipartisanship, there are simpler, more elegant solutions to this problem. This research creates a network of congressional votes and uses Google’s PageRank to determine the centrality of congressmen and bills. These centrality scores are then used in conjunction with principles of network theory, such as the bridge and cluster model, to effectively determine how the centrality scores correlate with bipartisanship. Currently, the model suggests that most bipartisan member of the Senate is Lisa Murkowski (R-AK). Research is in progress to compound the bipartisan score of a bill with the scores of the congressmen. With an accurate measurement of bipartisanship, the causes of polarization can be better identified and solutions to end polarization can be effectively created.


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How does the method of processing data affect memory retention?

Morgan Newcomb

People used to use pen and paper to write down and record information. Now with cellphones, computers and other technologies on the rise, a majority of people are switching over to other methods such as typing and texting. Is it better for memory retention to type or to write by hand? If hand writing proves superior to typing, how can schools integrate the same muscle memory into newer technologies? Conversely, if typing is shown to be better for memory retention, would schools abolish and discourage the use of hand written assignments and notes? This experiment consists of two experimental groups and a constant to determine which method is best for memory retention. Test subjects were administered codes via different methodologies. Then, they were asked to recall the codes. The results of their memory retention were tallied. Using an ANOVA test, it is determined that with this experimental design, there was no significant difference in memory retention between the various testing methods. Thus, further research would have to be conducted to validate the original hypothesis.

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The Effect of Ocimum tenuiflorum (Tulsi) on Fluoride Levels in Water

Mrudula Bandaru
Julia Nguyen

In third world countries high fluoride levels in water result in problems such as bone decay, skeletal fluorosis, and damage to the nervous system but using Tulsi can be a cheap and accessible solution to these problems. This experiment was conducted in order to determine if Ocimum tenuiflorum is capable of reducing fluoride levels in water. The hypothesis states that if Tulsi (paste or leaves) is soaked in water containing a high concentration of sodium fluoride, then it will lower the fluoride content. For this experiment, sodium fluoride (14 mL) was added into cups containing 100 mL of distilled water. Tulsi paste and leaves were placed in the cups and then tested for fluoride content in five 10 minute intervals using fluoride detection strips (0 minutes as the control). The fluoride strips determined if the solution possessed a high, medium, or low amount of fluoride based on the colors and amount of rings on the test paper. Based on the results, Tulsi overall reduced the concentration of sodium fluoride in distilled water and the null hypothesis was rejected for the majority of paste and plant tests. This can be explained due to the plant’s unique chemical properties. It is made up of various phyto-chemical compounds that possess strong antioxidant properties. While the experiment shows that Tulsi is capable of reducing fluoride, it would be beneficial to research further in order to understand how Tulsi is able to absorb fluoride and the exact quantitative amount of fluoride absorption.


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The Effect of Casein in Soy, Whole, and Almond Milk Coagulation

Aditi Bawa

For the last 20 years, muscle building has been one of the many growing fads in this country, especially with teenage and middle aged men. The purpose of this experiment was to simulate conditions in the human stomach, and observe which type of milk (whole, soy, or almond) coagulated the most. The hypothesis was that whole milk would produce the most coagulate, because it contains the least amount of glucomacropeptide, which inhibits coagulation. Also, whole milk has about 10 g of protein, as compared to soy milk which has 8 g, and almond milk which has 7 g. This added protein, along with the amounts of casein, makes it such that the casein micelles aggregate, and cause formation of coagulate.

Four trials of six experimental groups each were tested with increasing amounts of casein and added to 300mL of whole, soy, and almond milk. At 85 degrees Celsius, the casein was added and at 37°Celsius, 15 mL of vinegar was added. After 1 minute and 30 seconds, the coagulate separated from the whey and was measured.

The results showed that whole milk produced the most coagulate as compared to soy and almond milk regardless of the amount of casein. Therefore, the hypothesis was supported by the experiment, and the null hypothesis, that whole milk produces the least amount of coagulate, had to be rejected. A regression and correlation test was carried out and analyzed to further confirm this data.

To further better this experiment, different types of casein such as alpha S-1, alpha S-2, Beta, or Kappa could be the independent variable. Also, the coagulation of different types of cow milk could have been tested.

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Prevention of Digoxin Breakdown via Microbial Action Using Arginine

Nicole Behrooz

The leading cause of death in America is heart disease. Many treat heart disease with digoxin, a medicine derived from the digitalis plant. Some individuals harbor bacteria, Eggerthella lenta, in their stomachs which ingest the drug and reduce its efficacy. The amino acid L-arginine may prevent these bacteria from destroying the drug by repressing the genes which initiate the breakdown of the drug.

The purpose of this research was to determine whether L-arginine would prevent another common gut bacterium, E. coli, from breaking down digoxin. Digoxin was added to E. coli cultures, incubated for one week at 34 degrees Celsius, and the breakdown was measured using a spectrophotometer.

Statistical analysis via t-test indicated there was a significant breakdown of digoxin when exposed to E. coli. However, when the bacteria were treated with L-arginine, metabolism of digoxin decreased considerably. Hence, it appeared that the arginine played some role in the prevention of drug degradation due to bacterial action. Further research would entail the exploration of drug breakdown via additional bacterial species. This research is important because it indicates the existence of other common gut flora which can decrease the efficiency of the drugs we take.


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The World’s Fuel Fix; Is It Algae Biofuel?

Milap Lavani
Marisela Martinez

If recent measurements suggesting algae derived fuel as a substitute for fossil fuel survive scrutiny, the questions regarding its practical applications will arise. Therefore, the intent of this research was to determine the potential ethanol yield between two of the most abundant algae strains, and their effect on the environment. Ethanol yield holds a direct correlation to a fuel’s potential for biofuel thus signifying its importance in the struggle to find the next replacement for fossil fuel derived energy.

In this experiment Euglena gracilis and Chlorella (IV) algae strains were separated and cultivated within a controlled environmental chamber with a temperature of 28°C and a productive (light) period of 18 hours. Both algae strains were then measured for productivity via dissolved oxygen, and fuel grade alcohol yield though the process of fermentation. It was found that Euglena gracilis had a higher percent yield of ethanol than Chlorella.

The student’s t-test was performed, and as a result the null hypothesis was accepted as it maintained p-values of 0.0001 and 0.0020 (highly significant), for Euglena gracilis and Chlorella respectively. This in turn contradicted the original experimental hypothesis: That the Chlorella strain of algae would produce the largest output of dissolved oxygen and lipid content, thus resulting in the highest yield of ethanol. Hence, the experimental hypothesis was rejected because Euglena gracilis observed a greater yield of DO and ethanol instead of Chlorella. Therefore, the findings of this experiment suggest Euglena gracilis has a better practical implication as tomorrow’s fuel source in comparison to Chlorella, as it produces greater amounts of both ethanol and DO over a 3 month period.


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The Peroxide Effect

Mary Lunde

As oil shipments around the world are becoming more and more common, the likelihood of another catastrophic oil spill is at its highest. The problem of how to clean up these dangerous chemical spills without causing additional harm to the environment is now a major concern. With some initial research, it was found that hydrogen peroxide has been used in some bioremediation methods. Yet, the question of how the addition of hydrogen peroxide affected the water was never addressed. How does the hydrogen peroxide change the pH and dissolved oxygen levels in the oil-infused sea water? The hypothesis stated that the addition of hydrogen peroxide would cause the solution to become more basic with a lower level of dissolved oxygen. In a thirty-trial experiment, hydrogen peroxide was added in different increments to the oil-infused sea water solution. Once the solutions was stirred, the pH and dissolved oxygen levels were recorded from each beaker. The statistics did not support the hypothesis and instead suggested a positive correlation between the addition of the hydrogen peroxide to the dissolved oxygen level and a negative correlation between the hydrogen peroxide and the pH level. Though the slight decrease of pH value due to the hydrogen peroxide could add to the acidification of the ocean, the likelihood that this would have a significant influence is minimal. The dissolved oxygen level increase, would not cause a significant change to the inhabitants, however too much of an increase could interfere with fish respiration. Thus, this experiment suggests that hydrogen peroxide does contribute to the breakdown of complex hydrocarbons in oil without harsh, lasting consequences on the marine ecosystem.


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Marine dinoflagellates cause breathtaking, glowing tides when they are agitated by mechanical stress from ocean waves. This bioluminescence is crucial to survival for dinoflagellates, like Pyrocystis fusiformis, and scientists use bioluminescence to track the progress of diseases and test neuron communication in humans. In this experiment, three groups of four Pyrocystis fusiformis cultures were kept in different light/dark cycles (photoperiods). The control group was cultures that were kept in twelve hours of light and twelve hours of dark each day. The IV, amount of exposure to light, was changed to twenty-four hours of dark for one experimental group and twenty-four hours of light for the other to test the effect on the DV, brightness of bioluminescence, which was recorded on a qualitative scale (1-9) after Pyrocystis fusiformis was agitated every night. The results showed that maximum bioluminescence occurred under the normal photoperiod of the control group. The chi-square test showed that the IV impacted the DV, P<.05. The experimental groups glowed less brightly because the scintillons, where bioluminescence occurs, couldn’t obtain protons needed for the reaction without the light phase, and not enough scintillons were present without the dark phase. The mode was 4 for the light group and 3 for the dark group. However, the control group had a higher mode of 7. The alternative hypothesis stated that if exposure to light decreases, then the brightness of bioluminescence will increase, and it was not supported. Further research could explore other ways to increase brightness of bioluminescence for medical use.
Diet-based Inhibition of Acetylcholinesterase as a Treatment for Myasthenia Gravis and Alzheimer’s disease

Elishama Michel

Myasthenia Gravis (MG) is an autoimmune and neurodegenerative disorder characterized by disturbances in nerve-muscle communication caused by auto-immune system complications. Antibodies mistake muscle acetylcholine receptors as foreign invaders and block the binding of acetylcholine (ACh) thereby preventing the signal for muscle activation. Alzheimer’s Disease (AD) is characterized by a decrease of production of the ACh. The enzyme acetylcholinesterase (AChE) normally degrades ACh in order to turn off its signal. Current treatments for MG and AD involve synthetic AChE-inhibitors such as Pyridostigmine. These drugs increase the amount of Ach in the gap by slowing its degradation, effectively increasing the chances of successful nerve-muscle communication. The goal of this research is to find additional AChE-inhibitors in foods that may help to supplement MG and AD treatment. Extracts of various fruits and vegetables were made and tested in a spectrophotometric based AChE-inhibition assay. Concentrations of each extract required for 50% inhibition (IC50 values) were calculated in order to quantitatively compare their AChE-inhibiting properties. Preliminary data analysis suggests that brussel sprouts and broccoli are the most potent natural inhibitors. Further analysis of their methods of inhibition is underway. These findings demonstrate that natural AChE-inhibitors exist in foods and a structured diet could be used to augment MG and AD treatment.


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The Effect of Grapefruit, Orange, and Lemon on the Inhibition of Cytochrome P450 Enzymes

Neelum Patel

The basis of this experiment is to determine the inhibition of cytochrome P450 enzymes when they are exposed to various citrus fruits such as grapefruit, orange, and lemon by determining if orange and lemon juice also carry the same compound furanocoumarin in grapefruit which is known to inhibit the enzyme. The hypothesis stated that if lemon and orange juices are tested with Allegra, then the enzyme will be inhibited by lemon juice but not by orange juice. The positive control group was grapefruit juice and distilled water was the negative control. The inhibition was tested by running a total of ten trials of conductivity tests per juice on solutions of Allegra with enzyme immersed in the various fruit juices. The quantity of Allegra, enzyme, and juice that was used was kept constant. A positive value for the conductivity reading showed that inhibition did not occur while a negative value implied that the enzyme was inhibited which was determined based on the control groups. The results of the conductivity test showed that lemon juice did not inhibit the enzyme since the average conductivity value was positive 2.70 and orange juice did inhibit the enzyme since the average conductivity value was negative 1.00. The results of this experiment could impact those that are taking medications that are known to have terrible side effects with grapefruit but do not include information about taking the medication in conjunction with other citrus fruits such as orange juice which has been proven to carry the compound furanocoumarin which will adversely interact with the metabolism of the medication.


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The Effect of Insertion of pAMP Plasmid into Various Gut Bacteria

Toshali Randev

One in 12,000 infants is born with phenylketonuria (PKU), an autosomal recessive genetic disorder in which production of phenylalanine hydroxylase (PAH) is hindered. Thus, PKU patients cannot ingest phenylalanine without risking adverse brain damage or seizures. The object of this experiment was to discover whether a PAH plasmid could be inserted into gut bacteria that would do the part of a nonfunctional PAH gene by catabolizing phenylalanine if ingested. Because a PAH plasmid has not yet been extracted and made available for use in various bacteria, an ampicillin-resistance plasmid, whose markers are found on the TB-cell PAH plasmid, was used. The hypothesis states that if strains of Lactobacillus acidophilus, Escherichia coli, Bacillus cereus, and Enterobacter cloacae are genetically modified by insertion this plasmid, then they will grow in nutrient broth containing ampicillin. The control trials for each bacteria were not transformed. Each species of bacteria was first cultured on agar plates, and then transformed using sterile technique. The transformed bacteria were placed in LB broth in test tubes, and the percent transmittance of each trial was measured using a spectrophotometer. After a 48-hour period of incubation at 37 C, the percent transmittance was again measured. The results showed that all four bacteria did successfully transform, as indicated by a negative change in percent transmittance of light, as well as T-test p-values of 0.000605584, 1.94674E-14, 1.89105E-14, and 2.13785E-08 for E. coli, B. cereus, E. cloacae, and L. acidophilus, respectively. A layer of qualitative data was added by growing untransformed bacteria of all four species on phenylalanine agar, then adding ferric chloride to determine a color change indicating natural breakdown of Phe by the bacteria; this is known as the phenylalanine deaminase test.


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# Cellular & Molecular Biology (400)

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<td>406X12</td>
<td>Walther, Ashley</td>
<td>The Effect of Protease Enzymes on the Conjugative Success of Antibiotic Resistant E. coli</td>
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Does the Type of Fruit Affect How Much DNA can be Extracted?

Shannon Connors

In this experiment, I tested to see if different fruits have different amounts of DNA. I started by making sure each fruit group had the same mass (Table 1.1). I then dehydrated all of the fruits and then rehydrated them all with the same amount of water. I used ten different fruits, and tested each fruit ten times. The fruits I used were strawberries, kiwis, cherries, apples, bananas, mangos, blueberries, pineapples, grapes, and nectarines. For all of the fruits I got some amount of DNA, all except for the mangos and cherries. I averaged out all the amounts of DNA for each fruit, and came up with the following:

Strawberry .08 g
Kiwi .04 g
Cherry 0 g
Apple .02 g
Banana .08 g
Mango 0 g
Blueberry .01 g
Pineapple .03 g
Grape .04 g
Nectarine .08 g

I was able to conclude that the strawberries, bananas, and nectarines all had the most DNA out of all the fruits (on average). Although by using the amounts on their own, I would be able to conclude that the strawberries contained the most DNA.

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How Does Ginkgo biloba Help Treat Alzheimer’s Disease

Crystal Gong

Ginkgo biloba is an herb that’s long been used to treat memory and cognitive disorders, such as Alzheimer’s disease. Ginkgo has been shown to increase norepinephrine (octopamine in invertebrates) in the brain, and this increased norepinephrine may reduce beta-amyloid plaque in Alzheimer’s patients. The link between ginkgo and Alzheimer’s treatment was confirmed in the model organism C. elegans. Worms treated with ginkgo had less beta-amyloid plaque than worms not treated with ginkgo (Wu et al, 2006), but the molecular mechanism for ginkgo’s reduction of plaque is not known. However, it is likely that ginkgo reduces plaque by increasing octopamine (norepinephrine in vertebrates). This project will use RT-PCR to test for upregulation of mRNA that codes for enzymes in the octopamine synthesis pathway. Worms treated with ginkgo should have higher levels of mRNA coding for these enzymes than worms not treated. Control trials using untreated worms have already been run, and Cq values have been obtained to use as a baseline. Synchronized worms are being treated with 0.1% of a standardized ginkgo biloba extract, EGb761, and will be prepped for mRNA extraction 6 days after initial exposure. The Cq values for treated and nontreated worms will be analyzed using the delta-delta Cq method, or the comparative method. Providing evidence for Ginkgo biloba’s molecular basis will help support ginkgo’s use as a safe, effective medicine.


Wu, Yanjue; Wu, Zhixin; Butko, Peter; et al. (2006). Amyloid-beta-induced pathological behaviors are suppressed by Ginkgo biloba extract EGb 761 and ginkgolides in transgenic Caenorhabditis elegans. Journal of Neuroscience. 26(50): 13102-13113. DOI: 10.1523/JNEUROSCI.3448-06.2006

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Selective modulation of the permeability of the blood-brain barrier (BBB) to therapeutic macromolecules using adenosine receptor signaling in an in vitro model

Anna Maximova

Many therapeutic drugs that have the ability to treat diseases of the central nervous system (CNS) are unfortunately unable to do so because their access to the brain is blocked by the blood-brain barrier (BBB). One recent study showed that tight junction proteins are altered by activating A2A adenosine receptors on the endothelial cells of the BBB, via specific A2A agonists, thus increasing the permeability of the BBB temporarily for high molecular weight drugs. The purpose of this research is to investigate the effect of a previously untested A2A agonist, 2-phenylaminoadenosine, on the permeability of the human BBB in an in vitro model. Endothelial cells were used to seed inserts of a Transwell® well-plate system, which creates two chambers to represent blood and brain. This model was then used to test the effect of the agonist 2-phenylaminoadenosine, which was done by administering a specific amount of a test antibody, anti-dengue virus (clone 3H5) primary antibody, to the top chamber of a Transwell® system, allowing time for passage, and then sampling from the bottom chamber. The amount of antibody that passed through the cell monolayer was determined by performing an ELISA and calculating the concentration found in the bottom chamber by comparing absorbance values to a standard curve for the 3H5 antibody. Data collection is ongoing and no definite conclusions can be made at this time. If potentially therapeutic antibodies can indeed cross the BBB using this approach, this might provide a non-invasive treatment option for currently difficult-to-treat CNS diseases.


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Telomere Extension via Cycloastragenol in Human Dermal Fibroblasts

Romtin Nadjafi

Telomere length is a key factor in the proliferation and aging of cells. Telomeres shorten with each cell division, and cells undergo a programmed death once their telomeres reach a critical length. Telomerase is the enzyme responsible for lengthening telomeres, but is heavily regulated and repressed in most cell types. Telomerase activators allow telomerase to operate, but are not present in high enough quantities in humans to effectively extend telomeres. The purpose of this research was to determine whether cycloastragenol, a telomerase activator, can lengthen the telomeres of human dermal fibroblasts. Because dermal fibroblasts are responsible for the healing of the skin, increasing longevity could enhance healing. After culturing and supplementing, DNA was extracted and used for qPCR analysis and gel electrophoresis. QPCR and gel electrophoresis analysis is ongoing at this time.


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The Effect of Ultraviolet Light on the Respiration of Yeast Cells

Emily Rovder

Skin cancer occurs when there is damage to the DNA of skin cells. This cancer is most often caused by ultraviolet radiation, which comes from the sun. This damage causes mutation, genetic defects and causes skin cells to multiply forming tumors. Skin cancer is the most common form of cancer in the United States, and more than two million Americans are affected by this cancer each year. The purpose of this experiment is to see when ultraviolet light begins to affect the respiration of yeast cells. The independent variable was the amount of time the yeast was exposed to ultraviolet light. There were four different groups of times exposed to the UV light: no exposure, five minutes, ten minutes, and fifteen minutes. Each group had fifteen trials and the amount of CO2 that the cells respired was measured using a CO2 sensor (ppm) after given a sugar solution and left to sit for ten minutes. My hypothesis was supported that the longer the yeast were exposed to the UV light the more effect it would have on the respiration produced by the yeast. The average mean amount of CO2 produced by control group was 1855 ppm and the average mean for the fifteen minute group was 921 ppm. Further research could be done to see what other cellular functions are affected by Ultraviolet light in a short period of time.


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The Effect of Protease Enzymes on the Conjugative Success of Antibiotic Resistant E. coli

Ashley Walther

Antibiotic resistance is a steadily rising and increasingly aggressive problem for modern day healthcare. The spread of antibiotic resistance is hastened by conjugation, the main method of horizontal gene transfer in bacteria. Conjugation in E. coli uses a pilin protein bridge, called a sex pilus. If a forming or already formed sex pilus could be denatured, then the process of conjugation will be inhibited, therefore reducing the spread of plasmids that might contain antibiotic resistance. In this experiment, Pronase and Trypsin, non-specific protease enzymes, were applied to two pre-conjugative E. coli strains, one possessing a Streptomycin antibiotic resistance, the other Ampicillin resistant. The protease enzymes were applied to the bacteria in microfuge tubes, then the mixture was spread on an agar medium containing Streptomycin and Ampicillin antibiotics. There was one control: a tube containing the two E. coli strains in which no enzyme was added. The hypothesis that Trypsin would hinder conjugation was supported based on qualitative data. The control plates showed growth after 24 hours, while the E. coli strains exposed to Trypsin in the microfuge tubes did not grow on an antibiotic medium, proving that they were unable to conjugation. Pronase was ineffective on inhibiting conjugation, as there was consistent bacterial growth on control and variable plates. Further research could explore how protease enzymes could be used, possibly in tandem, with antibiotics, to prevent conjugation in vitro.


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## Chemistry (500)

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The Effect of the Ratio of Iron Oxide to Aluminum Powder

Edward Calley

Thermite can be used for various applications including welding. The strength of a thermite weld depends on the composition of the thermite. Using different amounts of iron oxide and aluminum powder, one can manipulate the thermite reaction and the strength of the resulting weld. To find the ideal ratio, three different thermite formulas were used to weld steel rods together. The ratios tested were 3:1, 1:1, and 1:3 of iron oxide to aluminum powder. Two steel rods were placed in a mold and the thermite was then poured into the mold and ignited. Once cool, the strength of the weld was tested by placing the welded rod onto two rollers and adding weights onto the weld until the steel rods broke or bent apart. These steps were repeated using each thermite formula. The results show that the thermite formulas using the 1:3 ratio of iron oxide to aluminum powder maintained the strongest weld of the three formulas tested. Although less iron was used, the 1:3 ratio thermite reactions were less violent and therefore able to better weld the two steel rods. Although the results of the experiment did not support the thesis, the purpose of the study was still achieved. The strongest thermite formula was found. A question that could be addressed in further research would be the type and structure of the mold used when welding with thermite.

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Producing Liquid-Resistant Nylon Coatings

Vamshi Garikapati
Neha Goswami

Coatings are used industrially for protection, and by incorporating a hydrophobic agent into the coatings, they can increase the longevity of equipment by preventing damage from contact with corrosive liquids. Nylon is a common coating used on machinery, but it is not hydrophobic. Previous research on hydrophobic coatings has added an extra, liquid-repelling, layer above a pre-existing coating to make a material hydrophobic. The problem with these coatings is that the uppermost layer is subject to abrasion, and therefore loses its liquid-resistant properties over time. This research seeks to solve this problem by chemically embedding a hydrophobic monomer, POSS, directly in nylon coatings to avoid adding a second coating. The POSS-modified nylon was dip-coated onto an aluminum substrate, mimicking the nylon coatings on machinery. Omniprobicity, the ability of a surface to resist wetting from Newtonian and non-Newtonian fluids, was tested by measuring contact angles of various liquids on nylon-coated aluminum, and contact angles were used to calculate surface energies of the nylon coatings. Results have shown that POSS-modified nylon coatings demonstrate hydrophobicity; its contact angles were greater than 90 degrees, whereas unmodified nylon coatings exhibited low contact angles below 70 degrees. These high contact angles yield low surface energies, and both indicate that the coatings have successfully been modified to resist wetting. Research is in progress to determine the optimum concentration of POSS in nylon 6,6 to achieve overall superomniphobicity. This will provide insight to a new and effective approach of coating materials to increase efficiency in commercial industry.


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Remediation of Industrial Pipe Scaling via Crassostrea virginica Protein

Taylor Newman

Scaling, the buildup of minerals such as calcium carbonate in pipes, cause issues in the efficiency of pipes in moving liquids in industrial and agricultural settings. Minerals are prevalent in water that runs through pipes, hence removal is imperative. Some scaling treatments involve flushing pipes with acids which are harmful to the environment. Since seashells are a composite of protein and calcium carbonate, it was the intent of this research to determine whether the proteins could be used to cause a reduction in calcium carbonate mass. Proteins were extracted from oyster shells and calcium carbonate was treated with this protein to determine what, if any breakdown occurs. Due to the exploration of different protein extraction methods, research is ongoing at this time.


Gunthorpe M.E, Sikes C.S, and A.P. Wheeler. 1990. Promotiona and Inhibition of Calcium Carbonate Crystallization In Vitro by Matrix Protein From Blue Crab Exoskeleton.


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Graphene Composites as an Alternative Organic Fuel cell Catalyst

Keithen Orson

Fuel cells present a unique, carbon emission free alternative to fossil fuels, but the cost and performance of current commercial platinum catalyst keeps them from widespread use. In this work investigates the effectiveness of different self-reduced graphene composites compared to a commercial platinum black catalyst. These graphene catalysts present an opportunity for creating a low cost, high performance catalyst using non-hazardous and commercially scalable methods. Various types of graphene were prepared by self-reduction on copper, and then were combined with iron (II) phthalocyanine via sonication. The catalysts were electrochemically characterized with cyclic voltammetry using a three electrode setup. Preliminary research indicates that the synthesis of the different graphene composites was successful. Research is ongoing.


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# Computer Science (600)

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The Effect of Computer Operating Systems on Overall System Performance

Rishabh Akhaury
Hammad Khan

With a plethora of Operating Systems (OS) available for computers, users have the freedom to demo and experiment with them for their liking. The purpose of this experiment was to find which OS will deliver the highest performance, in the interest of consumers. The dependent variable was system performance measured by benchmarks and FPS and the independent variable were the types of computer operating systems which were Windows 7 and Ubuntu 12.04 LTS. In this experiment, a system was tested and measured. The computer had Windows 7 Home Premium and Ubuntu 12.04 LTS installed with the latest drivers on both OS’s. Multiple benchmarks and games were installed to test performance when the systems were put under pressure. The benchmarks stress tests were initiated and ran for certain periods of time. The Geekbench, Passmark, and Peacekeeper software were used for benchmarking the system in different categories. For further testing, Minecraft and Team Fortress 2 games were played and average FPS were measured. A T-test was done and yielded results of $t(8) = 1.76, 2.25, 3.27, 4.7, \text{ and } 7.7$ for significance comparisons between Windows single/multi cores to Linux single/multi cores. The null was rejected as the values showed little overlapping.


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Improving the Accuracy of Speech Recognition Through Improved Language Models

Henry Conklin

The purpose of this study was to find areas of improvement for the Sphinx 4 (http://cmusphinx.sourceforge.net/) speech recognition engine and for speech recognition in general. Sphinx 4 is open source project collaboration between the Sphinx group at Carnegie Mellon University, Sun Microsystems Laboratories, Mitsubishi Electric Research Labs, and Hewlett-Packard with contributions from University of California Santa Cruz and Massachusetts Institute of Technology as a Java based method for recognition of live and linear as well as prerecorded audio sources like video or broadcast television. This task was approached from the angle of improving the language model which is used to extract the most likely sentence from a clip of audio. Java and Python applications were developed to extract and reformat training data to apply to the engine. It was hypothesized that using a large enough pool of training text would greatly improve the accuracy of the generated model. Through the generation of models using different culling parameters, it was possible to create a model with higher accuracy than a control of currently existing models for general purpose speech recognition.


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Automated American Sign Language Translation

Hannah Devinney

The project seeks to build a system that uses the FORTH 3D HandTracking Library (an API for a framework to track hands in 3D) in conjunction with a 3D camera to identify handshape, one of the key components of a sign in American Sign Language (ASL). The program will focus on classifiers, a specific category of handshapes, which have wide applications in ASL including classifier predicates and lexicalized signs, and in gestural control for natural user interfaces. The code will build a model of the hand based on data from the 3D camera using an “initialization position” as a control for the location of the hand when the program begins running. It will then extract the matrices that compose that model, and compare the matrices to those of known handshapes in order to identify the input. Tests will be repeated entirely every time the code is updated.

Progress to date includes building a working program that builds the model of the hand, but does not identify any inputs, as well as building a working program that builds the model and extracts the matrices of the model (currently being debugged). Research is ongoing: current and future versions of the code will offer handshape identification.


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Who Will Stand On The Podium in Rio 2016?

Noah Holt

The purpose of this project is to determine which Olympic athletes have the greatest probability of receiving a medal in the Rio Summer Olympic Games in 2016. Data was collected on projected athletes for their respective event from every county that will be represented. This data was then mapped using ArcGIS software and analyzed to project medalists in each selected event.


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The Effect of Cyber-Attacks on U.S. Financial Institutions

Ramsha Saad

In light of recent events, with the Bank of America falling victim to a cyber-attack, this shows that no matter the protection of how safe a system may be, such big systems are vulnerable to attacks coming, in ways to harm a financial institution for financial gain. With attacks such as this happening in the manner of a DDOS (Distributed Denial of Service) it shows how a cyber-attack occurs, and if a mitigation device knows how to differentiate normal traffic from attack traffic. Usually attacks like this often come from countries that compete with the U.S.'s economic power for their own financial gain. With this in mind, thirty packets of attack traffic were sent to a server to see if the attack traffic would be detected or not. Overall, all sources of attack traffic were caught since the mitigation device was able to get them all. In this experiment, the effects of attack traffic are that it can cause a system to shut down or buffer as it is not able to function properly. With this, it shows that if this happens with a financial institution, the customer or the person who has their money in a financial institution will not get their money as efficiently, since the process is delayed or stopped, and because of this it can cause a delay for so many individuals, in something they might want, which has a tremendous effect on them and the financial institutions, which are under attack.

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Enhanced Healthcare Data Processing through Implementation of Microsoft SQL

Matthew Szlec

On launch the HealthCare.gov website used to implement the Affordable Care Act suffered significant usage issues as the number of people using it to apply for healthcare insurance was much greater than initially predicted. With a more efficient data processing technique, the issues could have been greatly reduced. Despite the long-time use of data processing software such as SQL, such issues still occur and the significant amount of big data which is collected every year is much greater than the amount that can be properly processed.

The purpose of this research was to develop a better method for processing of big data using the example of healthcare data like that which would be found on the HealthCare.gov website. Through the use of Microsoft SQL, a functioning program was written to efficiently process large amounts of healthcare data simulated based off of comparable results to those found on the website itself.

From running multiple iterations of the program, t-test showed that processing time was faster per input unit than the website after factoring out server send and return speeds. Possible reasons for this could include the involvement of further bottlenecks due to having to send data to government servers and back. Were this research to be continued, further development and testing on a larger scale involving adapting the program to a constant stream, multi-user data processing structure would give a better simulation of the website and therefore greater insight on how to prevent issues like those faced by HealthCare.gov.


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The Effect of an El Nino Year on a Hurricane’s Intensity

Mark Armstrong
Danielle Townsend

In today’s society, the prediction of hurricane intensity and its impact on civilization is increasingly more pertinent. The purpose of this experiment was to indicate if there is a relationship between hurricane intensity and El Niño Southern Oscillation (ENSO). The independent variable is the ENSO year and the dependent variable is the intensity of the hurricane. For this experiment, the National Oceanic and Atmospheric Administration website was used to collect hurricane category and wind speed for the past 100 years. Using the Saffir-Simpson Scale the categories were used to compare hurricanes during ENSO years and years with normal conditions. The statistical analysis of hurricane category and wind speed for ENSO years and normal years included running the Mann-Whitney Test, which compared several data points for the ENSO and non-ENSO data sets. The Mann-Whitney Test was used in order to account for the hurricane data being not normally distributed. The P value was 0.2509 which is less than 1 therefore making this statistic insignificant, meaning this would have a probable chance of happening. To make a more accurate conclusion to the experiment, the wind speeds were collected along with the categories to narrow down the similarities or differences between ENSO and normal weather patterns. The P value was 0.3762 which is less than 1; once again this indicates that this could happen by probable chance. The null hypothesis was rejected. Both tests showed the similar results, indicating that the relationship between the two different patterns exists. Although the results were promising, further investigation of hurricane characteristics, including amounts of precipitation and central pressure, relating to El Niño would further test the relationship between the ENSO and hurricanes.


The Impact of Glacial Melting and Resulting Salinity Levels on the Photic Level Position of Amphidinium carterae

Lauren Buttling

Phytoplankton are responsible for 60-85% of the oxygen in Earth’s atmosphere and are the integral base of the marine food chain. In optimal conditions, the dinoflagellate, Amphidinium carterae, reproduces by binary fission and releases ichtyotoxins. Due to the melting of the polar ice caps, Amphidinium carterae’s aquatic habitats have experienced salinity fluctuations up to ±5 ppt. The purpose of this research was to determine if changing levels of salinity impact Amphidinium carterae’s position in the photic zone. In order to mimic glacial melting, a salinity gradient was created by mixing Amphidinium carterae’s optimal salinity level with saltwater of various salinities. Five trials of five different salinity gradients were filmed for 5 minutes and ImageJ was used to determine percentage of phytoplankton located in the zones 1 (top), 2 (middle), and 3 (bottom). Statistical analysis via a t-test indicated a significant difference between dinoflagellate photic level positions with the greatest sinking rate occurring when the salinity gradient was 27-33 ppt. This sinking makes these important members of the food chain unable to photosynthesize; hence they die and are not available as a food source. Regions with influxes of fresh water will experience a decline in photosynthesizing dinoflagellate populations; therefore, these aquatic habitats will undergo a destabilization of their food chains and decrease dissolved oxygen concentrations. Further research would entail the exploration of salinity on the effect of other photosynthetic members of marine food chains as a result of salinity decrease due to glacial melting.


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How Sea Temperatures Affect Hurricanes

Caleb Jones

I used data from the NHC to find the number of tropical storms, hurricanes, and major hurricanes each year. Data from NOAA was used to find the average yearly SSTs for 3 regions that would best represent tropical cyclone formation: Southern North Atlantic 1 (6°N-18°N 20°W-90°W, abbr: SNA1); Southern North Atlantic 2 (6°N-28°N 20°W-90°W, abbr: SNA2); Gulf of Mexico and North West Atlantic (18°N-30°N 65°W-100°W, abbr: GNWA). A fourth region was created by averaging the SSTs of the SNA1 and the SSTs of the GNWA. I then compared the tropical cyclone data to the SST data in scatter plots and used linear regression to find P and R² values for each type of tropical cyclone in each region. In all regions, except GNWA, increases in tropical storms and hurricanes were correlated with increases in SSTs based on a P value of less than 0.05. Major hurricanes had similar correlation in the SNA1 as well as in the SNA2 region. Small R² values means that there are other forces in addition to temperature acting upon the formation of tropical cyclones. The SNA1 region can be most attributed to the formation of hurricanes due to having the highest correlation and the largest R² values for each type of the tropical cyclones.

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The Effect of Striking Piezoelectric Materials on a Rechargeable Battery

Nicholas Tupaj

The experiment was to determine if a rechargeable battery can be charged by voltage output from striking the right piezoelectric material enough. Different piezoelectric materials were struck a constant number of times. Wires connected to material were connected to a rechargeable battery. After each trial, the voltage of the battery was measured and recorded. Thirty trials were run on three different materials. The hypothesis was “If the right piezoelectric material is struck for a long enough time, enough electricity will be produced to charge a rechargeable battery.” Even though quartz and sugar produced no output, the Rochelle salt charged a battery an average of 0.06 volts per trial and therefore is “the right piezoelectric material.” At this rate it would take 25 hours to charge the battery to 1.5 volts. ANOVA statistical analysis performed on the recorded data resulted in a very low P-value of 4.47 E-31, suggesting the Alternate Hypothesis was supported: “If Rochelle salt, sugar, and quartz are struck the same amount of times from the same height with the same striking stick, then their mean amount of voltage change would be different for each material.” The input to this experiment was a motor that used much more electricity than the experiment produced. The key to making this idea useful in everyday life is to use something that is occurring anyway to cause the striking or vibrating force on the material. This could be man-made vibrations like vehicles on a road or people walking, or natural forces like rain, wind, or waves. Further research could be done on the difference in output voltage when the material is struck harder by having the material and number of hits stay constant, but letting the Independent Variable be the height the stick is dropped from.

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Destabilization of soil can be caused by excessive water saturation which fills spaces between soil particles resulting in liquefied soil. During soil liquefaction, strength, stiffness and overall stability of soil deteriorates due to excessive amounts of water present from natural disasters such as earthquakes, and floods. Soil liquefaction can cause building structures to lose their foundations due to soil instability.

The purpose of this research was to determine whether colloidal silica grout successfully reduces excessive permeation of water through soil which tends to occur during liquefaction. PVC pipes were vertically elevated above collecting cups. Different concentrations of colloidal silica grout was added to wet and dry soil and placed into the pipes. One hundred milliliters of water was added to the soil after gelation and the amount of water which permeated the soil was measured. Statistical analysis via t-tests indicated a significant difference in soil stabilization between wet soil treated with 10% by weight colloidal silica grout and the wet control. Treated wet soil exhibited less permeation. The dry soil control and the dry soil stabilized with 10% and 30% by weight colloidal silica absorbed most of the water during testing. Considering ground soil’s natural moisture content, this research supports the use of colloidal silica grout to reduce liquefaction in loose wet soils. Further research could be conducted on a larger scale with the colloidal silica grout being injected into the soil to determine if it is still effective in mitigating liquefaction.


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The Efficiency of a Voltaic Pile Compared to a Store Bought Battery

Zackory Biggers

The purpose of this experiment is to determine whether a homemade voltaic pile is more efficient than a store bought battery. The null hypothesis being tested is that there is no difference between the battery and voltaic piles, while the alternate hypothesis states that if a voltaic pile of equal size or cost and a store bought battery are tested, then the store bought battery will have a greater voltage and amperage. To do this experiment, the voltage and amperage of 9V, D, C, AA, AAA, AAAA and N batteries were measured using a digital multimeter. Voltaic piles of approximately the same size as the batteries and then approximately the same price were created and their voltage and amperage were measured. In every case, the voltage and amperage of the store bought batteries was greater than that of the voltaic piles. Store bought batteries are significantly more efficient than comparable voltaic piles (for most groups, a significant difference was found even at p values of 0.01). They have greater voltage and amperage and can be small sizes while still maintaining their efficiency.

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The Effect of Headphone Structure on the Intensity of Sound Towards the Tympanic Membrane

Se Min Chung

The purpose of this experiment was to test if the structure of an earphone had an effect on the level of sound going towards the Tympanic membrane. This research was inspired through observing various news articles of unfortunate deaths that occurred due to the volume that a person listens to music, which sometimes is beyond the safe level of 60 dB. To this day, there are still no way of getting back hearing that is already damaged. Therefore, through this experiment the results will reflect the suggestion if the structure of the earphone is further from the Tympanic membrane, then the level of intensity of sound will be less. In order to conduct the experiment, first, the model of the ear starting from the outer area up to the region where the Tympanic membrane would be was built. Then, by using the sound level meter and the three different types of earphones, the same song was played at the same volume for the same duration. After conducting the trial, the conclusion did not match the hypothesis. The data collected showed that the classic Apple earphones which were structured to be the furthest from the sound level meter with an average of 79.95 dB. The average for the earphones by Urban beatz, which is structured so that is goes into the ear, was 77.24 dB. The last earphone, the Earpod by Apple, had an average of 77.74 dB. These results showed that even though the structures were different, there was not a significant difference between the three different earphones.


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The purpose of the project was to use a force pressure sensor resistor with a program to tell a robotic arm when it has sensed that it has picked up an object. I took a robotic arm, an arduino board with a wiring board, a power supply, and a force pressure sensor resistor and created a program to tell the robotic arm to go down and pick up an object using the pressure received from the sensor. I wrote a program and synced it with the arduino board, built the wiring circuit to control the motors, and combined the two with the arm. Then attached the sensor to the gripper for when it goes to grab an object, the sensor will send a digital number to the arduino board, goes to the circuit board, which tells the gripper to stop closing when it has sensed a certain amount of pressure. Results from creating the program showed using the sensor, the arm could be told when to close the gripper and how hard. Further research would provide a better results with multiple objects, telling the arm exactly how much pressure it can apply to specifically to each object. In order to complete the further research project, a stronger arm would be needed and a more detailed sensor programmed in. This project would help advance the technology in prosthetics, becoming more detailed, more like a human hand.
The 360 Degrees Spray Applicator

Bailey Hwa

This project evaluated problems with existing common spray bottles (also referred to as "spray applicators"), particularly with their spray control at various liquid levels. As part of the project, a new and improved custom spray bottle was designed and built using off the shelf components to improve spray control (e.g., spraying at any desired pitch, roll and yaw angle) and to reduce the amount of wasted liquid, such as chemicals, undispensible through the spray mechanism. The new spray bottle uses a movable plunger to maintain a vacuum in the bottle so that all of the liquid is dispensable from the bottle at any spray angle through operation of the spray head. The spray bottles were tested and compared to evaluate their efficacy, which involved a comparison of wasted liquid measurements (in milliliters) at effective angle ranges for pitch (e.g., forward movement) and angle ranges for roll (e.g., sideways movement) for each spray bottle. The measurements showed that the new spray bottle was more effective than the tested common spray bottles. By using a single-factor ANOVA test, the following P-values were obtained: the P-value for the pitch measurements was 0.000024, and the P-value for the roll measurements was 0.00016. Since both P-values were less than 0.05, the collected measurements were significant. Custom components could be used to further improve the construction and design of the new spray bottle, such as using 3-D printer or other known manufacturing technologies.

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The Effect of Coil Wraps on the Output Level of a Pickup

Connor Manzelmann

Unlike an acoustic guitar that uses the sound board of the instrument to transport sound, the electric guitar produces audible sound through an electromagnetic device called a pickup. The pickup consists of cylinder magnets placed below each string wrapped by thousands of turns of copper wire. The vibrations of the strings are converted to an electric signal transmitted to the amplifier speaker. The purpose of the research is to determine how the number copper wire wraps (IV) affects the electrical output (DV measured in milli-volts) as well as sound quality. Pickups are too expensive to have several custom made with different wire turns so Mr. Fralin of Fralin Pickups prepared a pickup that was overwound with 9400 turns. For this experiment the pickup was incrementally modified by removing 200 copper wire turns each time measuring voltage output and sound quality using a Sine Wave Function Generator and Oscilloscope. The results showed that increased copper turns did increase voltage output and the higher the number of copper turns above standard (7000-8000 turns) the lower the sound quality. Overall the measurements support the hypotheses that copper wire turns on an electric guitar pickup affect voltage output, and a measurable effect on sound quality. A further study that may be considered is does sound quality max out at manufacturer’s standard and quality decrease below 7000 turns.

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The Effective Spring Constants of Springs in Parallel and Series Arrangements

Jamie Morris

The purpose of the experiment is to determine the significance of spring constants in parallel and series configurations. The hypothesis is, "If the springs are combined in parallel, then the effective spring constant will be the sum of the two, because the springs are both acting independently on the weight. If the springs are connected in series, then the effective spring constant will be less, because the springs are acting dependently."

The procedure was as follows: The single spring experiment was executed. Weight in grams either extended or compressed 10 springs. The displacement was recorded in millimeters. The parallel spring experiment was executed. Weight compressed 9 pairs of springs, and displacement was recorded. The series spring experiment was executed. Weight extended 10 pairs of springs, and displacement was recorded.

The line of best fit was then computed in the graphs. This is called the spring constant. Stiffer springs have high spring constants while flexible springs have low spring constants. These measured constants were compared to the theoretical constants derived by formulas based on Hooke's Law.

The Parallel Experiment's data supported the hypothesis for pairs A, B, D, E, and G. The Series Experiment's data supported the hypothesis for pairs J, K, L, O, Q, R, and S. A T-Test was performed between the theoretical and measured constants and the P value was under 5% for the majority of the time.

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The Effect of Magnet Size and Amount of Coils on Volts Produced

William Ogle

The purpose of this experiment is to understand how to make a more efficient generator by examining how the magnet size and the number of coils affect the voltage produced. The experiment had six independent variables consisting of three different sizes of magnets, 5cm, 7cm, and 10cm and the three amounts of wire turns; 50, 100, and 150. The dependent variable was the number of volts produced. The control was a frame with no magnet or wire turns. The procedure included building nine generators with different magnet sizes attached to a nail inside a frame wrapped with the appropriate number of wires. The magnets were spun using a drill at a constant speed for twenty seconds with a measurement in volts taken every second by a volt meter. The results supported the alternative hypothesis that increasing the magnet size and the number of wire turns will increase the output voltage. An ANOVA test was conducted on the data and yielded a p-value less than 0.05, thus rejecting the null that size of magnets and number of coils would have no effect on voltage produced. This statistical analysis confirmed that changing the number of wire turns and magnet size does have a significant effect on the voltage output of the generator. Further research could be done to examine how rotation speed and the material of the wire effects the voltage produced.


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The Effect of Different Antenna Geometry on Signal Strength

Eric Potak

This experiment tested the optimal geometry of a Yagi antenna to produce the strongest signal. The results of this could potentially improve the signals of Wi-Fi in households, thus improve the standard of living. Four antennas were tested; antenna A had five elements of 12 AWG (American Wire Gauge), spaced 10 cm apart; Antenna B had five elements, 12 AWG, spaced 20 cm apart; Antenna C had nine elements, 14 AWG; Antenna D had nine elements, 12 AWG, and spaced five cm apart each. The control was a router without an antenna attached. The constants included the distance from the router to the antenna, antenna to the computer, the program used to record data, and the router computer used to test the data.

An ANOVA was used to compare the means of all the antennas. The mean for Antenna A was -50.33 dB, B was -47.6 dB, C was 49.67 dB, D was -48.8 dB, and the control's mean was -54.67 dB (p<.05). T tables compared the means between the antennas. Compared to the control, the signal strength of all the antennas were strong (p<.05). Antenna A versus antenna B was the only significant t test among the antennas (p<.05). Antenna B had the greatest difference (p<.05) because it had the largest diameter wire, the most spacing and 5 elements. These are the best traits for the overall geometry of an antenna. The next question is, through proper laboratory testing, "what industrious materials will create the strongest signal?"


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The Effectiveness of Fans With and Without Blades

Victoria Whelan

The problem in this experiment was whether bladed or bladeless fans were the most effective, to see which one is the better consumer choice to purchase. Effectiveness here was measured by the wind speed, which was measured in units of rotations per minute or RPM. The independent variable in this experiment was the type of fan, bladed or bladeless. The dependent variable was the wind speed in RPM, taken with an anemometer. There were 15 trials in the experiment. The original hypothesis was that bladeless fans would be more effective because they seemed to have more advanced and efficient technology from research. The procedures involved constructing a homemade anemometer out of Dixie cups, straws and pencils, and taping the anemometer to the table the fan would be on to make it as sturdy as possible. Then, the fan was placed in front of the anemometer and the RPM was measured manually every time the cups of the anemometer made a full rotation. The manual counting continued for one minute for each trial. After 15 trials, the data concluded that the mean of the RPM of the bladed fan was 31.73, and the mean of the RPM of the bladeless fan was 73.4. The original hypothesis was correct, and the null hypothesis was rejected, because the bladeless fan had a higher wind speed, which was the definition of effectiveness. Although this project was very basic, the implications of creating an optimal engine for a fan, not only for personal use, but for use in larger scale operations, such as jet engines or car engines, can be explored further with the knowledge gained from this project.

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Super Stretchy Hybrid Hydrogels for Tissue Regeneration

Emily Beatty

Hydrogels are extremely porous polymer networks that when placed in water can swell hundreds to thousands of times their dry weight. The medical applications of hydrogels are synthesizing them so that they can be substituted for human tissue if it is missing, diseased, or damaged. The current dilemma surrounding hydrogels is that they are mechanically weak. Current hydrogels, although effective, tend to deteriorate quickly because they cannot keep up with the same function that real muscle and tissue must perform on a daily basis. The goal is to create a hydrogel that will have a robust tensile strength and elasticity to better mimic tissue and muscle in the human body. These aspects were investigated in my experiment of an acrylic acid alginate hybrid hydrogel. Although previous work has been done using two polymers, one of these polymers was acrylamide, a carcinogen. I have hypothesized that acrylic acid, a polymer that is related to acrylamide but harmless, can be substituted due to a similarity in acrylate arrangements and can be combined with alginate to produce a strong yet harmless hydrogel. So far, I have run both tensile strength and elasticity tests on my experimental group. Stress versus strain graphs indicate that the hybrid gel can be stretched a greater distance and can withstand more force than both control groups (a gel just composed of alginate and a gel just composed of acrylic acid). Research is ongoing.


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Elimination of Microbial Electrostatic Adhesions on Biomedical Implants

Alison Carney

Many people receive hip and knee replacements as they get older. However, many of these replacements can become infected with bacteria anywhere from three to four weeks post-surgical procedure to ten to twelve years later. Bacteria which cause infections display an electrical charge, attracting them to implants.

The purpose of this research was to determine if the reduction of static electricity on hip replacements would cause less bacterial growth due to the loss of electrical attraction. Six samples of implant metal were tested: blasted and polished wrought titanium alloy, wrought cobalt-chrome alloy, and cast cobalt-chrome alloy. These samples of metal were tested as produced, with a added plastic coating, and with a plastic and vitamin E coating. Implant samples were incubated in liquid cultures of Staphylococcus epidermidis and subsequently samples were plated from the implants. The percentage of bacterial growth from each implant type and treatment was determined via ImageJ.

Electrical charge produced by the implants coated with bacteria was also noted. Statistical analysis via a t-test indicated a significant lack of bacterial growth on implants coated with vitamin E as opposed to the plastic coating and no coating. Hence vitamin E decreased the electrical attraction between the microbes and the implant which could subsequently prevent infection. Further research would entail testing different types of coating to see which can reduce the electrical attraction between bacteria and implants. Globally, this is important to reducing additional painful procedures due to post-surgical infections.


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Development of Small-Scale Robotic Fingers to Scale Down Force using Nitinol Actuation

Ian Dillingham

Nitinol, a metal consisting of equal parts nickel and titanium, presents many unique forms of actuation due to its shape memory properties. Because nitinol exists in two phases while in the solid state, it is capable of shape memory. By heating nitinol beyond a specific temperature range, just below the boiling point of water, the molecules realign themselves to their preset positions. Through the application of thermal energy both in forms of thermal conduction and electrical conduction the molecules will realign themselves just the same. The purpose of this experiment is twofold: to create a method of making uniform nitinol coils that behave consistently when an electric current is applied; and to develop a clamp mechanism that is operated by nitinol actuation. Because, nitinol coils contract with forces around one Newton or less, depending on the voltage across the wire and the dimensions of the coil, clamps that are operated by nitinol actuation are advantageous because there is little to no risk of crushing the object that needs to be clamped and moved. Research is still ongoing whether or not coils manufactured with this study’s methods perform consistently when the voltage across is the same. Development of the clamp mechanism is also still in progress.


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Reducing Traumatic Head Injury by Introducing Elastomeric Silicone to Hockey Helmets

Timothy Garnier
Olivia Landgrover

The goal of this study is to determine if the introduction of an additional layer of silicone rubber in addition to industry-standard helmet materials used in the traditional design of hockey helmets reduces the forces delivered to the head in the event of an impact. Furthermore, it aims to determine if the durometer, a measure of hardness of the silicone rubber layer, has any influence on said reduction in forces, and if so, what the ideal durometer for such a layer would be for optimum force reduction and therefore minimized risk. A reliable model of a hockey collision has been developed that allows for testing x, y, and z-components of force and simulated impacts at various angles. Control data has been gathered, establishing a baseline for comparison for ongoing research. Future results will indicate whether or not the introduction of silicone would be a beneficial design change to hockey helmets and protective equipment in general.


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Making 3D printed products stronger: Comparing compressive and shear strengths of different infill patterns of 3D printed thermoplastic

Sindy Hou

3D printing using fused deposition modeling (FDM) has been expanding since the 1980’s and has demonstrated prints with great durability. Though market 3D printers are becoming more popular in the commercial world, minimal research has been conducted with quantifiable results on the durability of the printed products. When a solid object is being made, printing programs automatically select infill patterns: designs that fill the inside of the object to keep the structure intact but save on printing material and time. The purpose of this research is to determine which patterns have the greatest compressive and shear strengths. Each of the seven infill-patterns from a widely-used printing program, Slic3r, was created at 10% infill and printed in cylinders and rectangular prisms. Cylinders were then crushed with a hydraulic press and their compressive moduli were compared. To test for shear strength, midsections of the rectangular prism were pressed downward until the middle slid apart from the ends. The forces needed to break the prisms for each pattern were then compared. Conclusions of the research will be available upon completion of trials and will be used to optimize the strengths of 3D printed products in future prints, as 3D printing becomes more available to the marketplace.


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The Normal Forces on Different Materials Optimal for Football Gloves

Pranava Komaragiri

There are many football gloves on the market each using different materials, but which one was the most optimal one to use? Which material out of Latex, Neoprene, and Butyl, which are the most commonly used materials for football gloves, is the best material that is used for football gloves. Two experiments were done to answer this problem; the first was a drop test to find at what distance in a tube does each material stop a football. The second was finding the coefficient of friction using a lab quest. With the first experiment the stopping distance was found and the Frictional Force was calculated from it, and with the second experiment "\( \mu \)" (coefficient of friction) was found, and by dividing Frictional Force by "\( \mu \)" the Normal force was found, this was repeated for each material, and mimics the force required to catch a football. Latex showed to be the material with the least normal force, which was 1.197, neoprene was 1.195 and butyl was 2.443. The null hypothesis was accepted when comparing latex and neoprene, but was rejected when comparing latex and butyl, and neoprene and butyl. Thus a football player who uses latex gloves will require less effort because it takes less normal force to catch a football. If the experiment was continued the malleability of each material can be considered, and the way the human hands grip the football when caught can also be considered.


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The Effect of Silver Nanoparticles (AgNPs), or Acetylsalicylic acid, Alone or Synergistically, on the Prevention of Biofilm Formation on Thermoplastic Polyurethane as a Model for Indwelling, Intravenous Catheters and Dental Implants

Molly Lausten
Perri Solhjou

Bacterial biofilm formation poses a threat to patients who have devices as diverse as intravenous catheters and dental implants. Bacteria growing on these devices can produce biofilms that prevent antibiotic penetration and periodically seed in systemic infections. The purpose of this study was to determine the efficacy of silver nanoparticles (AgNPs), alone or synergistically, with acetylsalicylic acid on the reduction of biofilm formation by Enterobacter aerogenes, Pseudomonas fluorescens, and Serratia marcescens, organisms related to strains that cause serious nosocomial infections.

Small squares of thermoplastic polyurethane (TPU) were prepared with no treatment, coated with AgNPs, mixed with acetylsalicylic acid, or treated with both AgNPs and acetylsalicylic. Each square of TPU was placed in the designated well of a 96-well microtiter plate. The three organisms were grown to stationary phase in Luria broth, then diluted 1:100 and added to every specified well of microtiter plate. The plates were incubated for 48 hours at 37°C. Each TPU square was washed and the attached biofilm was stained with 1% crystal violet. The stain on each TPU square was solubilized with acetic acid, and that solution was then analyzed in a spectrophotometer at 570nm. Initial results show that AgNPs inhibited biofilm on TPU material compared to the control (P greater than 0.05). AgNPs were shown to not be harmful to mammalian cell cultures. Further research could research the inhibitory effect of AgNPs on oral biofilm-specific bacteria.


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### Synthesis of Biocellulose Using Gluconacetobacter xylinus and Recycled Sugar Substrates

Andrew Lee  
Anokhi Patel

Biocellulose is a form of cellulose produced by bacteria, and has several advantages over plant derived cellulose. It lacks impurities like pectin and lignin, which promotes its biocompatibility, essential to use in the biomedical field. Furthermore, large water absorbance and internal structure of biocellulose enhance its drug delivery capacities. Biocellulose is produced by bacteria in the form of a pellicle, a mat of interwoven cellulose fibers and the most efficient producer of biocellulose is Gluconacetobacter xylinus. The cultivation of these bacteria requires a carbon source, often pure sugars like glucose and sucrose. Bacterial cellulose is not currently in mass production due to the high cost associated with utilizing pure sugars. The purpose of this experiment is to substitute pure sugars with waste fruit sugars and compare the physical properties of the resulting cellulose in terms of bioyield, water absorbance, tensile strength and drug diffusion capacities. Thus far, pellicles have been grown from waste apples and waste grapes. The bioyield and thickness, a precursor to tensile strength, of grape pellicles have been marginally greater than that of apple, but the apple pellicle has shown much greater water absorbance capacities. Currently, efforts are underway to produce pellicles using pure sucrose as a control. In addition, further tests of tensile strength and drug diffusion are in progress. It is expected that the cellulose produced from the waste sugar will be comparable to cellulose produced by pure glucose in both of these areas, at a significantly lower cost.


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The Effect of Helmet Lining on G-Force for Impact

Elizabeth Miller

Concussions are big problems in hockey. Therefore, this experiment changed the helmet lining to find which material was best for absorbing G-Force. The control group was the helmet with no lining. The independent variable was the helmet lining and the dependent variable was the G-Force. An iPod was used to measure the G-Force and it was taped into the helmet. Then, the helmet was dropped and the G-Force was recorded. The best lining was bubble wrap with stuffing with the mean of 3.1 G. The hypothesis was if the helmet was lined with concussion foam and bubble wrap, then there would be less G-Force. This was not supported by the data. Bubble wrap was the worst lining. This might be because of the force of the air on the iPod. Further research could explore why this happened. Also, gelatin could have been used to suspend the iPod.

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The Effect of Fabric Type on Shedability
Kelley Moser

This experiment was designed to further the effectiveness of crime scene investigation by determining if fabric type affects shedability. This information would help investigators know if fibers found are a good lead or just a common occurrence. Seven different fabric items, the independent variables, were rubbed ten times onto fifteen different carpet samples. The amount of fibers shed, or shedability, was determined by collecting the fibers onto pieces of packing tape and comparing them to a scale numbered 1-8. After data collection, the means of the wool, fleece, denim, polyester, cotton, linen, and rayon were 3.06, 2.26, 1.2, 0.00, 3.26, 1.4, and 2.06 respectively. The data was first compared with an Anova test which revealed significant difference. T-Tests were then run between each combination of fabrics. Of the 21 different t-Tests, only eight showed P<0.05. While the eight significant P values covered a fairly wide variety of fabrics, there was not enough evidence to support the hypothesis. The hypothesis is not supported by the data. Not enough of the t-Tests resulted in P<0.05 to prove that fabric type effects shedability. Based on this experiment, the independent variable, fabric type, does not seem to have a strong enough effect on the dependent variable, shedability, to make any type of generalizations about which fabrics transfer more fibers. Further research could investigate the effects of weave, tightness, dye, finish, and other such variables. Variables of this kind may have more of an effect on shedability than fabric type.


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Increasing the Efficiency of the Dye Sensitized Solar Cell Using Nano Layered Zinc Oxide

Aishwarya Saikumar

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 semiconductor, ZnO or TiO2, would produce the best results, and to see if the nano layered Zinc Oxide would increase the voltage output. The IV in this experiment was the type of semiconductor used, TiO2 and ZnO aggregates. The DV was the voltage output. The control group was the cell without any nano layered TiO2. The layered ZnO and TiO2 films provide a larger surface area, resulting in higher electron transfer and more absorption of light. The cells with ZnO proved to have better voltage outputs than those with TiO2. The average increase from the control group with the standard TiO2 DSSC and the nano layered ZnO DSSC was 80.08%. The average increase from the nano layered TiO2 and the nano layered DSSC was 19.81%, respectively. Results were significant. The alternative hypothesis stated that "If nano layered of ZnO of different sizes is used in the Dye Sensitized Solar Cell instead of TiO2, then the voltage output will increase. Based on the results and statistical test, this hypothesis was supported. The IVs, the nano layers of different sized TiO2 and ZnO, greatly influenced the DV, the voltage output. The improved performance of the DSSC is due to the higher efficiency of electron transfer, which resulted from the larger surface area provided by the ZnO nanostructure.


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The Effect of Solar Water Pasteurization Technique on the Pasteurization of Milk

Megan Thackaberry

Milk is often a staple in third world countries, but is also a major cause of disease. Pathogens may enter the milk through the animal’s feed or water. Milk can also be contaminated if it comes into contact with pathogens during the milking process, such as through the udder or human milking. The purpose of this experiment is to provide a safe and effective form of milk pasteurization that is capable of being used in third world countries. The hypothesis of this experiment stated that if the solar water pasteurization process is used on milk with added Escherichia coli, then the bacteria Escherichia coli introduced to the milk will be eradicated. 13 samples of 250 mL of milk and 30 microliters of Escherichia coli were combined and poured into a glass jar before being placed in a solar pasteurizer designed to hold the milk samples. These samples were subjected to the heat and wavelengths from three sun lamps and natural sunlight for 7 hours. Control samples were simply plated and placed in the incubator every day prior to experimentation. Following testing, the pasteurized samples were plated and allowed to incubate for 36 hours. The quantitative data was obtained by counting colonies and qualitative by simply observing the growth of the colonies in comparison to the controls. Data is still being gathered at this time. Further extensions of the project would include working with the pasteurizer without the aid of the heat lamps, but rather using the actual sun during the summer when there is increased solar intensity.


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Investigating the Applications of Mussel Proteins as a Component of a Nanofiber Mesh

Justin Trainor

Nanofiber meshes are currently being explored for use in tissue engineering applications. Proteins taken from the beard of the mussel Mytilus edulis have been shown to possess qualities that could be potentially useful in a 3D matrix for cellular growth, such as low immunogenicity and high biodegradability. The goal of this study was to find out if these proteins could be formed into nanofibers through electrospinning, and if these nanofibers could then be optimized for cellular growth and adhesion.

Isolated proteins were electrospun in combination with polyethylene oxide, a common co-polymer. By changing the field voltage of the system, nanofibers containing the mussel proteins were created with a variety of fiber diameters and levels of porosity. Nanofiber meshes were analyzed using scanning electron microscopy, and fiber diameters and porosity levels were measured. Beading in the mesh was also noted. Analysis showed that meshes spun at lower voltages had smaller fiber diameters and lower porosity levels, and also contained significant beading. Meshes spun at higher voltages had larger fiber diameters and porosity levels, with minimal beading. Research on other voltage levels is still in progress. Future work with these protein nanofibers may indicate that mussel proteins could serve as a component of structural matrices for tissue engineering applications.


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Electrospun Nanofibers as First-Aid

Varun Vishnubhatla

On the battlefield, wounds are very likely to get bacterial or viral infections. Adding an epidermal antibody patch can decrease the likelihood of this happening. The polymers PLGA and cellulose acetate were electrospun and tested for viability as media for antibody-based first-aid. The polymers were both dissolved in acetone and coated in an anti-streptavidin antibody buffer. In a series of enzyme-linked immune sorbent assay (ELISA) steps, a color change was achieved. The color change is a direct indicator of the amount of functional antibodies on the surface of a mesh. ELISA testing every two days for an eight-day period was used to determine the decay rate of antibodies on the surface of the mesh. The slower the decay rate, the more viable a mesh is for use as an epidermal patch.


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The Effect of Nepeta cataria Oil Infused onto Long-Lasting Insecticide Nets (LLINs) and Untreated Mosquito Nets on the Repulsion of Aedes albopictus.

Madeline Warndorf

The purpose of this experiment is to determine a more effective and economically viable innovation to current existing mosquito nets. This innovation may help increase the repulsion rate of malaria-transmitting mosquitoes away from the netting in developing countries. The use of Nepeta cataria (catnip) oil was determined through the results of previous experiments proving that the catnip oil causes a stronger repulsion rate than the insect-repellent, DEET. The independent variable was the presence of the catnip oil, “Impure”, “Pure”, and the leaves rubbed directly, on the nets. The “Impure” form of the oil was the steam-distillation of the dried catnip leaves/water mixture used to distill the catnip. The “Pure” form of the oil was the steam-distillation of the original oil collected from the dried catnip leaves/water mixture. The dependent variable was the repulsion rate of the Aedes albopictus (Asian Tiger Mosquito). The control group was the nets without the presence of catnip oil. The repulsion rate was determined through the use of a “choice chamber” created by placing the control on half of the tank and the catnip infused net on the other side. The hypothesis stated that the presence of catnip oil on the net, the repulsion rate of the Aedes albopictus will increase. The data supported this hypothesis with the averages showing more mosquitoes, 2.667 mosquitoes for the untreated net control and 2 for the oiled; 3.134 mosquitoes for the LLINs control and 2.8 for the oiled LLINs. Further experiments can examine the proof of the catnip oil.

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The Effect of Computers in Sleep Mode on Energy Consumption

Hasan Amjad
John Dooney

With the ongoing effort to help the environment, it is vital to see where any energy can be conserved. The purpose of this scientific experiment was to determine whether it is a cost and energy effective method to put computers in sleep mode every time they are not in use. The hypothesis was that if the computer being tested is put into sleep mode, it will take a significantly less amount of energy to stay running. To implement this experiment, the use of a WattsUp Pro data-logger and a standard school desktop computer (Dell Optiflex 780) was used. The WattsUp data-logger was plugged into the wall outlet where the computer's plug would be inserted, and the computer's plug was inserted into the data logger itself. The control was tested first (computer with no sleep mode), and showed that at each 30 second interval, about 58 watts were constantly being used. The same thing was done for the independent variable, which showed that only about 1.8 watts were constantly being used. The results showed that putting a computer in sleep mode was much more energy efficient and cost effective as it used a significantly less amount of wattage. One watt per hour for a commercial setting costs $0.008, meaning a computer sleep mode would cost $0.015 per hour, and a computer in regular mode would cost $0.48. This shows that putting computers into sleep mode every time they are not in use, even for 10 minutes, especially when there are hundreds of computers such as in a school or office setting, it would help conserve a large amount of energy and save a lot of money.


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Insight to the usage of renewable resources and systems revolving around them is high in demand. Geothermal Heat Pump systems significantly increase heating system performance with lower life-span costs and risk when compared to other temperature moderation methods. The purpose of this investigation was to examine a given closed horizontal geothermal loop field’s heat of extraction capability by recording the $T_{\text{in}}$/$T_{\text{out}}$ (using an electronic Amprobe thermometer) and outdoor ambient air temperatures measured from October 20-January 25 to enable more accurate loop field installations. With this data, equilibrium can be found and heat of extraction can be calculated. The expected outcome entailed the system maintaining steady-state for a duration of days. In the data analysis, $T_{\text{in}}$ was examined for these steady-state temperatures as the identified time periods where the heat of extraction is in equilibrium. The Statistical test of Regression was used. Through this statistical test, my experimental hypothesis was supported with an $R^2$ of 0.1328 which was used to determine the F Statistic (0.61) and therefore the P-value (>0.05). Consequently, one can conclude that a GHP (Geothermal Heat Pump) system has a steady-state capability in which the heat of extraction is at an equilibrium because the earth is producing as much heat as is being taken from it. These results could be especially beneficial to our understanding of our natural renewable resources and establishment of the limits of heat extraction therefore improving future geothermal loop field sizing for installations.

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<td>Sagar Govani</td>
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Liquid fuel rocket engines have complex parts and utilize high-pressure liquids for fuel therefore making them more prone to explosions and mechanical failure. Liquid fuel engines are used due to their ability to shut off midflight and easily vector thrust. However, this can also be achieved with solid fuel engines if their thrust curve is modeled for the rocket's mission. A model rocket engine with a parabolic thrust curve was used to hover a thrust vectoring test platform and gently land it. This test platform hovered due to plasma cut aluminum gimbal created for 180 degrees of rotation in each direction for the rocket motor. The motor's direction was altered with 2 high torque metal-g geared servos. These were controlled by an Arduino controller which utilized orientation values from an Internal Measurement Unit to determine the motor's angle. While this is a simple test, the engine's thrust curve can be used to model the rocket's mission. This reduces the engine's weight due to a solid fuel engine not having complex parts like fuel pumps and high-pressure tanks. It was determined that the Arduino microcontroller running at its clock speed of 16 mhz was too slow. This was evident as the test platform tended to overcorrect itself because the microcontroller could not check orientation fast enough. Although the platform overcorrected, it self-stabilized and successfully landed indicating that customized thrust curve in a solid fuel rocket can be used for basic flight control.


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The Effect of the Number of Solar Panels on the Amount of Time Required to Charge a Phone

Srivatsa Harish

People often find themselves in a situation where their cell phone is nearing zero percent and they do not have a place to charge. Solar chargers are a great alternative to portable battery chargers that could be more efficient and pose more of an impact on portable charging. The purpose of this experiment was to find if using more solar panels of the same amperage and voltage would charge a phone in less time. Three groups were tested a number of fifteen times. The independent variable was the number of solar panels and the dependent variable was the amount of time taken to charge the phone. The control was the time taken to charge a phone using a wall charger. The average time of the control was 154 min. The mean values for the one, two, and three solar panels were 0, 227, and 157 min, respectively. The alternative hypothesis that more solar panels would require less time to charge a cell phone was rejected.

A t-test was performed, resulting in t(28) = 1.1344E-16 with a p-value greater than .05 and therefore accepting the null hypothesis that the number of solar panels has no effect on the amount of time required to charge a phone. Further research includes testing the charging times using chargers with different watts or amps.


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Employing L-Systems to Engineer More Efficient Wind and Solar Powered Energy Towers

Yeonji Lee

Throughout history, the use of fossil fuels has created problems on a global scale. It was not until the turn of the twentieth century that nations turned to renewable energy to counteract health and environmental damage caused by burning fossil fuels. Wind and solar energy are renewable energy sources that are replacing fossil fuels. Unfortunately, large solar panels and wind turbines are unsightly. In addition, few turbines can be placed on land sections making vast acreage a necessity for large scale energy production. Solar panels and wind turbines are often used in tandem on different areas of land therefore making the combination of wind and solar powered energy a large investment. By combining wind and solar energy in a single tower with multiple turbines and panels, a significant amount of land use can be decreased. Wind turbines and solar panels were arranged using L-System mathematics to optimize surface area used in energy production. The amount of energy generated via voltage and current was measured. This was compared to energy production via conventional solar panel/wind turbine arrangements. Statistical analysis via t-test indicated that the wind energy produced by turbine placement using L-System mathematics was significant—nearly five times that of conventional wind turbines. However, the L-System arrangement of solar panels was not as efficient as conventional systems. Future research entails the exploration of the use of math to maximize energy system placement on a large scale with the hopes of decreasing our dependence on fossil fuels.


National Aeronautics and Space Administration. 2013. The current and future consequences of global change. Available online at: http://climate.nasa.gov/effects

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The Effect of Temperature on the Amount of Solar Energy Generated

Nirvan Mallepally

The sun produces enough energy in one minute to supply the world’s energy needs for one year. To use the sun’s energy, solar panels should be installed in every home as a less expensive and more efficient way of harnessing energy and reducing the electricity bill. People are skeptical to buy solar panels because of the popular misconception that solar panels do not work efficiently in cold weather. The purpose of this experiment was to find whether cold weather conditions have a negative effect on solar panel efficiency. For the experiment, a photovoltaic cell was placed in a refrigerator at five different settings and the voltage was measured and recorded. The independent variable was the different temperatures in the refrigerator. The dependent variable was the amount of solar power generated that was measured in volts by a voltmeter. The photovoltaic cell placed at room temperature was the control group. A One-Way ANOVA test yielded a result of $F(5, 571) = 2,346.605$ and a p-value less than 0.05. The results of the experiment were statistically significant and the null hypothesis that temperature would have no effect on volt output was rejected. The average potential voltage for the experimental groups was 5.4616 v while the control group was 4.821 v supporting the experimental hypothesis that if the temperatures are decreased, then it will not negatively affect the amount of energy solar panels can produce. Further research could test a higher variety of warm and cold temperatures to see the full effect of solar panels.


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An Exploration for Genetic Homologs for Use in Biofuel Production

Megan McElroy

Many factories, companies and homes rely on the use of fossil fuels to provide the energy used in daily activities. Fossil fuels are nonrenewable resources that create large amounts of energy but whose use causes harmful effects on the environment. Alternative sources of biofuel for energy use, such as the use of algal oil produced from green microalgae, can be a cleaner, renewable source for energy production. The purpose of this research was to identify enzymes and proteins within known green microalgae that were responsible for the production of oil in algae and, using this knowledge, determine whether similar enzymes existed within other organisms. Two enzymes, Botryococcus squalene synthase, squalene synthase, and the WRINKLED1 protein were blasted using the NCBI BLAST (Basic Local Alignment Search Tool) program. The alignment percentage and E. values were used to determine the degree of similarity between known and possible genetic homologs. The results indicated that there are many other plant and algae species that carry the same or similar proteins that could be useful in biofuel production. Although harvesting oil can be a costly process, the benefits outweigh the costs. Further research would entail the attempt of using organisms containing these genes to produce biofuel. This could help replace the use of fossil fuels worldwide, decreasing pollution and greatly enhancing environmental health.


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The Effect of Wing Shape on the Amount of Lift Produced

Charles Neff

This project tests the effect of wing shape on the amount of lift produced. In the experiment, wing shape was the independent variable and the amount of lift produced was the dependent variable. The experiment selected control was the Swept Back wing category. The results: the Straight wing category performed the best with a mean lift value of 4.673 grams, the Elliptical wing category was second best with a mean lift value of 2.751 grams, and the Swept Back performed the worst with a lift value of 0.258 grams. Comparisons of the mean determined that the Swept Back wing produced the least amount of lift and the Straight Wing produced the greatest amount of lift. After performing an ANOVA and a t-Test the data was determined to be statistically different (P<0.05). The alternate hypothesis, If the glider has swept back wings then it will result in the greatest amount of lift, was rejected and the null hypothesis, If the glider has swept back wings then it will not result in the greatest amount of lift, was accepted. The data was obtained because the straight wings produce more lift at lower speeds. Swept back wings do not produce as much lift at lower speeds. Further research into this topic could include testing other wing shapes in the same way as these were tested to see how other wing shapes compare to each other.

NASA. (2010). Exploring flight research with experimental gliders.

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Investigating the Effect of Wing Twist on Vortex Strength During the Downstroke Phase of Slow Flight in Bats

Kohl Orson

To fly at low speeds, bats create a Leading Edge Vortex, or LEV, on their wings during flight. It has many benefits such as airflow reattachment and increased lift, which could benefit modern and future aircraft. The purpose of my project is to determine whether a difference in angle of attack across the span of a wing increases the strength of the vortex created at the leading edge during the downstroke of a bat’s wing. To test this, I built several models of a bat’s wing skeleton, varying the differential in angle of attack. I observed the airflow around the wings using a PIV apparatus. To do this, I refracted a laser into a 2D plane in the airflow normal to the circulation of the LEV and observed tracer particles with a high speed camera. Analysis was done with a PIV application based on MATLAB that will give a vector field of estimates of velocities at a grid of points within the illuminated field. The strengths of the LEVs will be compared by the vorticity and circulation of the vortices, and work is ongoing to discover what effect wing twist has.


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Optimizing Traffic Systems in the D.C. Area by Manipulating Signal Timings

Rohan Rane

The increase of urbanization of the modern world has led to an increase in traffic congestion. The two methods of optimizing traffic systems include expanding infrastructure or manipulating previous systems. In large cities, expanding infrastructure is seldom a feasible solution without compromising surrounding buildings. As a result, a method of optimizing intersections of high traffic volume through genetic algorithms applied to signal timings for respective phase sequences was chosen. Thus, optimization of these intersections would result in a reduction of vehicular wait times of cars, a decrease in pollution, and conservation of natural resources to increase traffic flow and productivity rates. Washington D.C. traffic data was used to model a specific intersection of high traffic congestion through the Extended Queue Time model. The outgoing traffic flow in this model was then modified further using Greenshield’s model specifically so that it could include traffic data retrieved from the Washington D.C. Department of Transportation. A Microsoft Excel model for the specific intersection was created by incorporating the two models. Work on applying a genetic algorithm to the model is still in progress.


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The Effect of Different Rocket Fin Designs on the Stability of a Rocket

Kyle Sakmyster

This experiment helps to show how something as simple as fin shapes can affect the way a rocket can fly through the air. The project tests the effectiveness of different fin shapes of, rounded fins, angled fins, pointed fins, and no fins as the control. By using each different fin type on a model rocket the project hopes to show what kind of fins for rockets would work best to reduce the amount of drag that is acted upon a rocket. This could help with any rocket/missile launch device to create as smooth of a flight as possible. To test this it is important to build model rockets with fins as mentioned and test it in a wind tunnel that records the drag coefficient acted upon the rockets. After testing this experiment it was clear that the rocket with angled fins had a mean of only 5.87 volts of drag acted upon it, while the rocket with no fins had 9.23 volts of drag! This project focuses on finding the best fin to make a rocket as stable in flight as possible and this is shown by the experiment. This project helped to bring out other questions such as, how would the drag force on a rocket affect the acceleration or how high the rocket can go? The project also sparked the question of, what would happen if the fin sizes were made larger or smaller, and how would this affect the drag acting on the rocket?


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The Effect of Plant Type on Ethanol Production

Owen Salyer
Abigail Ward

The concept of finding a new more reliable resource for fuel is slowly becoming more and more important. This study was designed to compare the amount of ethanol that different plants produce. The research method is to compare the amount of cellulosic ethanol produced from mushrooms, apples and switchgrass to the amount produced from woodchips. The hypothesis of the project was that the switchgrass would produce the most cellulosic ethanol. Research shows that wood is the most commonly used source for production of cellulosic ethanol therefore was used as the control group. Each trial includes the use of two enzymes, peroxidase and cellulase. After the enzymes broke down and converted the cellulose into cellulosic ethanol, the ethanol was measured using a graduated cylinder. Results from the experiment showed that switchgrass produced the most cellulosic ethanol. However, discrepancies were found in this experiment resulting in inconclusive data for many trials. Limitations included small amounts of enzymes, being able to get into the school on specific days, and the amount of beakers limited the number of trials. Prior to conducting the experiment it was unknown to the experimenter that the edible part of the plant would not produce ethanol. Therefore, the trials using apples and mushrooms did not result in any production of ethanol. However, the trials of wood and switchgrass did produce measurable amounts of ethanol. In conclusion, the comparison of switchgrass and wood supported the hypothesis.


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How Does the Length of the Wingspan Affect the Flight Distance of an Airplane?

Valerie Tran

The airplane, is a great invention, it was invented by Orville Write and Wilbur Write on December 17, 1903. But the airplane itself is an underappreciated piece of work. This is because of the recent increase in fuel cost, causing the demand for airplanes as a means for travel or transportation to decrease.

The purpose of this experiment is to see if an airplane can possibly consume less fuel, if the time in flight is reduced just by increasing the wingspan. The experiment itself is then set up with 3 different types of wings to provide a variety of possible outcomes when the experiment is being tested, the wing types are going to be tested is the highly swept wing, the moderately swept wing, and the slightly swept wing. Within each wing type there are 8 different lengths of wingspans that range from 20cm to 40cm. Each wingspan per wing type is then given three trails and the length of time lasted was recorded in seconds.

After the experiment was completed the results were quite clear that the wingspan does affect the time of flight for the airplane. Also the results in the experiment revealed that the average time for each wing type had about a one second difference for the time the airplane was in flight. In addition to the results, the observations in the experiment some questions that the scientist had was why was there a significant decline in time for all three wing types between the wingspan 20cm and 22.5 cm? Why was the time of flight increased for all three wing types when the wingspan 35 cm was tested?


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How do Timed Intervals of Oxygenation of Escherichia coli Affect the Rate of Fermentation of Glycerol Waste?

Braedon Urie

The world is deficient of energy resources, and has an excess of glycerol waste that holds accessible alternative energy solutions. This experiment was conducted to determine if there is a relationship between timed oxygenation intervals and the fermentation rate at which the Escherichia coli produced ethanol through glycerol digestion. This experiment is based on the ability of E.coli to perform aerobic respiration and fermentation in an anaerobic environment. The amount of ethanol produced by fermentation was dependent on the varying oxygenation intervals of the respective test group. The control was E.coli in glycerol in an oxygen free bio chamber. This anaerobic environment was achieved by filling the bio chamber with CO2, purging it of oxygen. Readings were taken using an ethanol sensor. This control was compared to two groups that were oxygenated for varying periods each day. There was a +.2% ethanol increase in group 2 and a -.1% decrease in group 3. The experimental hypothesis that exposing Escherichia coli to timed intervals of oxygenation will increase the ethanol produced by fermentation was not supported by data, thus having no significant effect on ethanol production. Major sources of error include the sensitivity of the ethanol sensor, and the small scale of the experiment itself. Further research may focus on altering E.coli respiratory pathways through genetic modification for higher ethanol production. Unlocking the hidden ethanol energy in glycerol through E.coli fermentation can provide alternatives to society’s energy needs.

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The Effectiveness of a Biogas Recovery System on Waste Reduction, Energy Production, and Natural Resource Conservation

Lana Vaillancourt

As the world population grows, communities are seeking ways to independently generate clean energy for their citizens. Biogas Recovery Systems can provide a simple, economical and efficient way for rural communities to independently create clean energy using human, animal and agricultural waste. The purpose of this study was to determine the effectiveness of a Biogas Recovery System, resulting in waste reduction, energy production, and natural resource conservation. In this experiment, a Biogas Recovery System was designed and engineered using various tanks and hardware parts, creating an airtight system in which methane gas can be generated and captured from animal and agricultural waste. After processed through a combustion turbine, this gas then has the potential to create natural, inexpensive energy for heating, lighting, and cooking. The independent variable was the source of energy the appliance was run on. The dependent variable was by how far the nonrenewable energy consumption is offset. Control groups included the test site, the system, and amount of waste added. The results found that a BRS was effective on waste reduction, energy production, and natural resource conservation. Waste was decomposed and reduced into compost and methane; methane gas was produced, creating the potential for energy production; and natural resources, such as natural gas and coal, had the potential to be conserved. This 15 gallon individual system produced on average 14 mL of methane gas daily, equating to one 100 watt light bulb powered for 40 hours, 1 pound of coal, or 1 pound of natural gas. The experimental hypothesis, that a BRS supported by a community will be able to offset the nonrenewable energy consumption, was supported in the experiment. Further research could explore the implementation of a BRS on a large scale to support a whole community.


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## Environmental Management (1100)

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Atlantic Bluefin Tuna Migration Patterns

Jessica Boaman
Victoria Callahan

A study was conducted on Atlantic Bluefin Tuna migration patterns. It was once thought that Atlantic Bluefin Tuna were split into two distinct populations, the East and West Atlantic, but the research suggests they cross migrate. The resources supported the alternative hypothesis, if the Atlantic Bluefin Tuna population is not split between the East and West Atlantic, then there is only one population that cross migrates throughout the year. The study was designed to find consistent, annually used patterns of migration for the summer and winter seasons. In order to find data, online sources such as Electronic Tagging and Population Structure of Atlantic Bluefin Tuna, Atlantic Bluefin Tuna: Population Dynamics, Ecology, Fisheries and Management, and Atlantic Bluefin Tuna Podcast Google Earth Tour were examined, as well as migration pattern maps showing where Atlantic Bluefin Tuna migrated during different years. The data is qualitative because we used diagrams and graphs. Our mode locations for the summer consisted of Coast of Maine, Coast of Spain and Portugal, and the Gulf of Mexico. The mode locations for the winter were Coast of North Carolina, East Atlantic, and Coast of Maine. There were multiple recorded migration patterns starting from the Coast of North Carolina and ending in the Mediterranean Sea. The data shows that Atlantic Bluefin Tuna migrate west across the Atlantic Ocean from winter to summer. This inaccurate theory of two distinct populations has caused two different fishing quotas for the east and the west; therefore, the world’s fisheries are endangering this tuna population. By clarifying Atlantic Bluefin Tuna migration patterns, the study proposes that there should be only one fishing quota limit.


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The Effect of Using Different Fabrics as Filters on the Turbidity of Filtered Water

Mehher Hasnany

The purpose of the experiment is how people who have a contaminated water source can purify it by using common fabrics. The hypothesis is if silk is used, rather than cotton and wool, to filter the polluted water, then the turbidity will be closest to that of the tap water. The independent variables are the fabric of the filters: cotton, silk, and wool. The dependent variables are the turbidities of filtered water, which is measured with a turbidity sensor. The control group is clean tap water. The constants are the three types of polluted water tested by each filter, using the same size filter, and the same amount of polluted water. When testing all three independent variables with the constant, all three types of polluted water, the quantitative data was varied. The samples were tested four times, rather than just once, with three different sensors but there was no trend in the results. The means for turbidity when dirt is filtered through various fabrics were 140.5; 79 and 185. The means for turbidity when sand is filtered through various fabrics were 550; 439.5 and 519.5. The means for turbidity when salt is filtered through various fabrics were 64.5; 107.5 and 82. The descriptive statistics show that the hypothesis is not supported from the mean or the range. For further research, an improvement to this experiment would be changing the dependent variable to a different way of measuring.


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Can Plants Infused with Gold Prolong Space Missions?

Lauren Herbine

The success of future long-term space missions will be dependent on maintaining safe levels of oxygen and producing enough food and clean water for the crews. The first steps towards being able to provide these necessities to our astronauts have been taken through hydroponic farming research: the growing of plants in water and nutrients. To address the problem of oxygen levels on space vessels, Bacopa caroliniana was infused with gold nanoparticles in an attempt to increase its photosynthetic rate by utilizing a special property of gold nanoparticles called surface plasmon resonance, in which the chlorophyll will emit its own light when exposed to UV radiation. With the ability to photosynthesize using light from grow-lights along with light from its own chlorophyll, plants should give off increased levels of oxygen. An increased photosynthetic rate (relative to non-infused plants) should also be able to be maintained in a reduced light setting, eliminating the need for additional energy aboard a space station. B. caroliniana was soaked in gold-colloid solution for five days as a protocol for nanoparticle uptake, confirming uptake with digestion and spectrophotometric analysis at 540nm. Plants were tested under reduced light and three control environments measuring dissolved oxygen as an indicator for photosynthetic rate. Analysis continues, though preliminary trends show that infused plants have similar dissolved oxygen levels in reduced light environments as in normal light environments, supporting the potential application of using freshwater hydroponic plants as a means of providing oxygen to future space missions.


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Economic Impact of Lionfish

Christopher Hopkins

Lionfish, native to the Indo-Pacific region, are now being found throughout the Caribbean. Lionfish are eating large numbers of native fish species, reducing the fish population and destroying coral reef communities. The focus of this study is the effect the lionfish invasion has had on the economies of the islands studied. The research was conducted by analyzing the number of lionfish ten years before and ten years after their introduction and the change in the Gross Domestic Product (GDP) of each island in that time. Data was collected from existing scientific research, including lionfish research by P.J. Schofield and GDP data from the World Bank. Data was analyzed to determine if the arrival of lionfish negatively affected the economies of the islands where GDP and lionfish data was available, including Aruba, Bermuda, Dominican Republic, Jamaica, Puerto Rico, and Saint Kitts. The independent variable was the number of lionfish that invaded each island and the dependent variable was the percent change in the GDP of each island. The result of this study showed a drop in the GDP; however the data was not significant, and failed to support my hypothesis. The Null hypothesis could not be rejected. After analyzing the data, the only island that had an increase in GDP percent was Puerto Rico while all of the other islands GDP percent decreased. A Spearman Rank correlation was computed and considered the data to be not significant in an attempt to demonstrate a correlation between lionfish and the GDP. Further research should be conducted to measure lionfish populations and their economic effect. A limitation to this research was the sample size of islands where both lionfish and GDP data was available as well as the number of years of data available post-lionfish.


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Cleaning up Pesticides using Titanium Dioxide

Grace Horvath

In modern agriculture, pesticides often run off to nearby bodies of water. These chemicals are detrimental to the ecosystem and are toxic to fish, aquatic plants, and, in some cases, humans. In prior research, titanium dioxide has been used as an effective photocatalyst that can degrade a variety of organic contaminants. Photocatalysis works when UV light rays catalyze reactions on the surface of titanium dioxide. This process involves hydroxyl radicals that initiate a series of reactions that degrade an organic contaminant. This experiment concerned deltamethrin, a commonly used pyrethroid insecticide. 0.5 mg/L (the concentration toxic to most fish) was prepared and amounts of titanium dioxide varying from 0-6 g/L were added to this solution. Each beaker was exposed to 364 nm and 264 nm of UV light for 50 minutes. HPLC was used to find the change in deltamethrin concentration after exposure. Trends in the data currently show no difference in deltamethrin concentration after it is exposed to titanium dioxide and long wave UV light. Additional trials are currently being run on short wave, higher energy, UV light. Though previous research has shown titanium dioxide photocatalysis to be effective in removal of other pyrethroid insecticides, this data shows that it does not work with deltamethrin. These results demonstrate that a different method must be found to alleviate this problem.


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Can Escherichia Coli K-12 be used as an alternative energy source as well as bioremediation of an oil spill?

Madison Moseley
Brittany Raffa

Anaerobic bacteria is often found in human waste as well as mud, this bacteria breaks down organic compounds and creates electrons; these electrons can then be used to create alternative energy. In terms of finding the right anaerobic bacteria, Escherichia coli k-12 has been used in countless research projects to demonstrate bioremediation and the possibility of it being a sustainable alternative fuel source. During testing, the controls need to be kept constant as obtaining a sample of rich mud from a creek bed allows a lot of variability. The control group in both aspects of our project is an oil spill without bacteria to clean up as well as a microbial cell without the use of bacteria. In terms of data collection, it's still an ongoing process but we believe that our hypothesis will be correct, that if E coli k-12 is used to successfully clean up oil spills, it can create energy sustainable enough to be considered an alternative fuel source for the future.


The Effect of Different Filter Medias on the Cleanliness of Water

Anna Shaw

Millions of people in the world have to live with the effects of unsafe drinking water, especially in third world countries. The water in these countries is contaminated with bacteria and pathogenic material. In order to make unclean water safe to drink, there have been several efforts to make filters that can be used effectively. Unfortunately, most of these complex filters are expensive or complicated to assemble. The intent of this research was to make a simple filter that can be easily assembled from simple materials that can be found almost anywhere in the world. The hypothesis of this experiment stated that the filter made with sand and cotton cloth would be the most effective in making the contaminated water safe to drink. Four simple filters were assembled: one with just cotton fabric, one with sand and cotton fabric, one with gravel and cotton fabric, and one with soil and cotton fabric. For one trial, four 25mL samples of distilled water each contaminated with 1mL of Euglena bacteria were assembled and viewed under a microscope to count how the number of bacteria before filtration, and then they were poured into each of the four filters. After filtration, the samples were viewed again and it the difference of bacteria before and after filtration was determined. All four filters were tested 15 times. The control sample of bacteria was not filtered. Though the hypothesis predicted sand to be the most effective filter, this was proven wrong when the filter with gravel and cotton cloth had the highest differences of bacteria before and after filtration, with an average difference of 8.8 contaminates. Consequently, a filter made of cotton and cloth would be an effective and inexpensive filter if needed in a third world country.


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The Viability of Nannochloropsis oculata in Building Structures as a Carbon Neutral Agent and Alternative Biofuel

Eric Velosky

In this project is provided a solution to reduce carbon dioxide in the air and provide a possible biofuel source convenient for the urban environment. Many scientists would agree that CO2 plays a major role in increasing global temperatures. It should also be noted that phytoplankton consumed a large amount of CO2. We have considered large scale concepts where phytoplankton are incorporated into lamp posts, buildings, and other structures. In this project a model lamp that holds phytoplankton was constructed. The final product was a clear cylindrical plastic container with a solar powered lamp attached on top and a battery powered air pump to circulate air into the container. The phytoplankton consumed an average of 4.8 mg CO2/L/hr. If this project were to be conducted on a larger scale, these lamps, and other structures incorporating phytoplankton, could be used in cities to draw CO2 out of the air. This would also provide a source for biofuel, and the residue from that process used as animal feed. Both of these processes would be carbon-neutral but, because less fossil fuel is being used, this would reduce the amount of CO2 in a city’s air.


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The Effect of Different Water Sources on the Growth of Plants

Jessika Amaya

Water is important to sustain life. However, if the ideal water source was not available, could it be replaced with another with little impact on the organism? This experiment shows if changing a plant's intended water source has an impact on growth. The independent variables were the different water sources. The dependent variable was the average growth height of the plant. The control group was the group given distilled water. Tagetes patula, or French marigolds, were potted in standard soil and left in a controlled environment for 28 days. During the testing period, 10 plants were given the designated water source and growth height was recorded. Results proved to be inconclusive. The mean height for all test groups were 0 cm of average growth as none grew. An ANOVA test was done to show statistical significance of average plant height. The alternative hypothesis, if water from a pond containing algae is gathered, then the French marigolds (Tagetes patula) watered with the water from that source will show better signs of growth compared to plants watered with other water sources, was not supported by the statistical test performed. The independent variable appeared to have no significant impact on the dependent variable as seen in through the plant growth average of the algae pond group which was 0 cm. This experiment could also be conducted under different circumstances, including potential simulated environments.


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The Effect of Oil Spills on the Hemolytic Activity of Amphidinium

Rodel Andrew Baloy

Dinoflagellates are organisms that play a major role in aquatic food chains. In addition, some species such as Amphidinium carterae also have profound health effects on organisms when their growth causes red tides, large algal blooms usually associated with harmful health effects via the production of biotoxins and hemolytic activity. Pollution as well causes trauma to many aquatic species, creating devastating chain reactions through the ecosystems.

The purpose of this research was to assess the hemolytic capabilities of Amphidinium carterae and the effects of oil pollution on these capabilities. Two groups of A. carterae were tested: one subjected to motor oil and one without. Blood was added to both groups to measure the effect of oil on the hemolytic activity of A. carterae. Statistical analysis via a t-test indicated that there was a significant difference between the hemolysis in both groups. Blood exposed to motor oil experienced less lysis via A. carterae than the blood exposed to seawater only. A possible explanation could be that the motor oil inhibits the hemolytic capabilities of A. carterae. Further research would entail exploring other environmental contaminants to determine their effect on the hemolytic activity of this dinoflagellate. By determining what pollutants affect hemolysis by these ocean organisms, recommendations can be made for better monitoring. This could decrease conditions which cause the presence of these dinoflagellates in harmful vast quantities while maintaining their numbers so as not to crash food chains.


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The Effect of Fluoride and Chlorine Levels in Local Water on the Heart Rate of Daphnia magna

Stephanie Barry

This experiment analyzed how water treatment chemicals affect the health of wildlife; specifically Daphnia magna. The fluoridation and addition of chlorine to drinking water have proven to benefit the oral health of humans, but chemicals could be harmful to organisms. Daphnia magna provide a clear reflection of the health of watersheds since they are so sensitive to chemical concentrations. For example, excessive amount of fluoride in local water, increases the heart rate of Daphnia magna. In this experiment Daphnia magna were exposed to water from a community pond and water from Goose Creek, for five minutes (independent variables) and their heart rates were measured in beats/min (dependent variable). The control was spring water. Comparison of mean heart rates showed that water from Goose Creek (268.93 beats/min) increased heart rate when compared to spring water (231.45 beats/min) (p<0.05) likely because of runoff/chemicals added by Loudoun Water. Pond water had no significant difference with either water sample (p>0.05). Although, the alternative hypothesis was supported by the quantitative data, it was not supported by evidence in chemical concentration. The next step concerning this issue would be to obtain more sensitive chemical tests and repeat measurements. If they pick up excessive traces of chemicals, then it would prove that fluoride and chlorine are harming the environment. If they do not, it is positive in that our watersheds are not being adversely affected by added chemicals. Further studies could examine the effects of lesser amounts of water treatment chemicals to find the ideal amount.


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The Effect of Ethylene Glycol on the Daphnia magna’s heart rate, reproduction, and lifespan

Navpreet Brar

Water Pollution has been caused by multiple toxins including Ethylene Glycol, which has negatively affected marine, land, and human ecosystems. Therefore, if varying concentrations of Ethylene Glycol (10%, 15%, and 25%) were added to Daphnia magna’s environment then it had a negative impact on Daphnia magna’s heart rate, reproduction, and lifespan. Fifteen Daphnia magna were placed in water without any toxins in it and the constants are culture of Daphnia magna, type of pipettes, goggles, lab apron, type of beakers, stopwatch, microscope, Antifreeze (contains Ethylene Glycol) and the environment it was tested in. The means of the heart rate were significantly different compared to the control (126.2 and 118.4 bpm), (p<0.05). The means for Daphnia magna’s heart rate, 10 ml, during hours 0 and 12 were 155 and 33 bpm. The means for Daphnia magna’s heart rate, 15 ml, during hours 0 and 12 were 170 and 20 bpm. The means for Daphnia magna heart rate, 25 ml, during hours 0 and 12 were 224 and 0 bpm. The alternative hypothesis was supported because the heart rate was significantly after addition of Ethylene Glycol despite the amount of time. Daphnia magna’s metabolism was low because it had been fed no food in the concentrations thus not having enough strength to fight off the toxin. The brain would not have enough oxygen due to increasing heart beat thus it cannot order other body parts to function and slowly body starts to shut down leading to death. The next step would be to test Daphnia magna in concentrations that are closer together (0.2%, 0.4%, or 0.6%) to be able to pinpoint where the water flea’s health started to deter.


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The Efficacy of Tumeric Powder and its Constituents on Tetramorium caespitum as Green Repellents

Adrian Calciu

The goal of this experiment was to test the derivatives of turmeric powder on ants, a common household pest, to determine which of the derivatives was responsible for turmeric's ability to repel ants. This research is significant because the isolation of an effective natural compound that is easily available to the public can lead to the replacement of current synthetic products which would lead to a decrease in the instance of cancers, birth defects, brain disorders, kidney disorders, and deaths as a result of the toxicity of synthetic pesticides (Meenakshi et al). The experiment was conducted using harvester ants and derivatives that made up a large percentage of turmeric such as zingiberene oil and curcumin. Curcumin is a natural health supplement and zingiberene oil, can be easily purchased from stores or over the internet. Cardamom, while not a derative, was also used as contains high amounts of 1,8-Cineole which has been shown to kill and repel insects. The results of the experiment showed that zingiberene oil was the most effective derivative repelling on average 3.7 ants out of the five used in each trial. The experiment also supported the ant repellent abilities of turmeric. The evidence that supports zingiberene's responsibility for turmeric's ant repellent properties should lead to the foundation of different practices in the production of insect repellents to produce more environmentally friendly and less toxic products using natural derivatives such as zingiberene oil.

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The Effect of Water Toxicity on the Aquatic Organism Daphnia magna

Shane Curtis

The purpose of my experiment of the effects of water toxicity on the aquatic organism, Daphnia Magna, was to find out which of the four water sources held the most pollutants and why. The experiment's procedure was to first take the daphnia out of the original tank and put them in the four water samples, 12 daphnia in each. Then, observations were made based on the reaction of the daphnia to the new water. After they acclimated, external things such as temperature, pH, and alkalinity were all measured each day. The Daphnia were fed food, provided in the culture kit from Carolina Biological Supply, every other day. The data showed that the population of Daphnia in the water samples decreased quickly over time, each sample losing almost two Daphnia Magna per day. All water samples were kept in the same room temperature, which did not affect the Daphnia Magna viability, but the two water samples with lower alkalinity and more acidic pH levels lost more viable Daphnia quicker, therefore the sample with high alkalinity and more basic pH levels, held the Daphnia viable for a longer period of time. These results supported the hypothesis in the way that it was predicted that Water Sample number 3 would have the most negative effects on the Daphnia. In conclusion, the data and research from this experiment explained how aquatic organisms can be affected by what humans (or animals) put in the waters of the community.

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The Effect of Nitrogen Enriched Soil on the Effectiveness of Bacillus thuringiensis

Jacqueline Dahl

The purpose of this experiment is to determine the effect of nitrogen fertilizer on the effectiveness of Bacillus thuringiensis insecticide, so that people can determine whether or not using a fertilizer increases or decreases the efficacy of the B.t insecticide or crops that are genetically modified to carry the gene that makes B.t as its own insecticide. In this experiment the efficacy was defined as the rate of death of hornworms. Then fertilizer was narrowed down to check specifically for the correlation of death rates of hornworms to levels of nitrate. To measure this, 10 hornworms were placed in each plot of fertilizer, a B.t insecticide was sprayed directly on the hornworm food. Death rates were measured in 24 hour time periods. Then 15 trials were conducted per fertilizer type. According to the data, there was no statistically significant difference between the efficacy of B.t and the level of nitrate in the fertilizer. A t-test was used to calculate this correlation. Since 7N had the least amount of nitrate of the fertilizers, that was used as the control. The hypothesis that a higher level of nitrate would increase the efficacy of B.t was not supported. The null hypothesis of no relationship between the level of nitrate in the fertilizer and the efficacy of B.t failed to reject. The next step for this experiment is to add other insecticides along with B.t to see which combination has the highest death rate of hornworms.


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An Analysis of the Effect of the Fukushima Dai-ichi Power Plant Meltdown on Western and Eastern Pacific Coast Fish

Jennifer Dao

In 2011, Japan suffered significant property damage as a result of a tsunami. Reactors and storage tanks at the Fukushima Dai-ichi nuclear plant were destroyed. Since these reactors did not properly cool, an explosion resulted, releasing radioactive fumes into the Fukushima precinct. In addition to radioactive fumes, water used to cool the reactors runs through the storage tanks containing radionuclides, thus contaminating the water. Thousands of barrels of contaminated water continue to leak into the Pacific Ocean.

The purpose of this research was to determine whether radioactive waters may have reached the west coast of the United States, by determining radiation levels various fish species from Japan, California, and China. Statistical analysis via t-tests indicated a significant difference between the radiation levels of the various fish tested. The fish from Chinese waters exhibited lower radiation levels than both the Japanese and California fish which both displayed similar levels of radiation. The contaminated water plume is traveling southeast towards the lower part of California. Based on these results, the radioactive water is likely to have traveled close to the west coast of the United States which explains the similar radiation levels in the California and Japanese fish. The Chinese fish live primarily in the Indo-Australian oceans, thus missing the radioactive plume. Further research must be conducted in order to determine how far the plume has traveled. This is imperative in order to prevent people from ingesting fish containing greater than recommended levels of radiation.


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The Effects of Turf Fertilizer Runoff on the Potomac River

Sinead Foley
Christina Guintu

The Algonkian Golf Course is located on a National Wildlife Preserve in close proximity to the Potomac River. It is possible that runoff collects various pesticides and nutrients from fertilizer on its way off of the golf course into the river. Our original hypothesis was that the turf fertilizer runoff would negatively affect the Potomac River water quality. We took water samples from two different locations, upstream (Algonkian Park boat ramp) and downstream (Algonkian Golf Course pond on hole 13). While taking the data, the weather varied from 5-0 inches of precipitation throughout the study. We tested for levels of pH, dissolved oxygen, ammonia, nitrite, and phosphate. Nitrite (NO2-) levels did not change upstream or downstream, staying at 0mg/L. The pH and dissolved oxygen (DO) levels varied the most between locations. DO upstream had an average of 8.24 mg/L, while downstream had an average of 8.52 mg/L. PH had an average of 7.4 upstream, and 7.8 downstream. Phosphate (PO43-) fluctuates in each water quality test for upstream, ranging from 0-0.5 mg/L, while downstream Phosphate levels remained the same throughout the experiment. In the Mann Whitney statistical test, the p value was greater than 0.05 making the effect not statistically significant. This could be because of the time period since the last fertilization, or the fact that Algonkian Golf Course does not lay fertilizer within twenty feet of any bodies of water. Our study could be used on other golf courses, ones that are not controlled by natural wildife preserves, because the amount of care about the health of the surrounding water may vary.


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Utilizing the Antimicrobial Properties of Silver Nanoparticles on Resin Substrates to Create an Efficient Water Filtration System

Margaret Hale

Clean drinking water is not readily available in all parts of the world. This research aims to ultimately develop a system that could be created and sustained in areas of need by identifying an ideal resin type such that when coupled with silver nanoparticles, it will maximize its antibacterial properties in a water system. The concentration of silver and mass of resin were kept constant, and the effectiveness of the filter was determined using a controlled contaminated sample of water (with either Bacillus megaterium or Escherichia coli) and measured by a percent reduction by area method. Three cation exchange resins were used, including weak acid hydrogen form, strong acid hydrogen form, and strong acid sodium form, to see which yielded the highest percent reduction. Control tests show that resin alone, without synthesized silver, is not adequate for removing bacteria to a safe level for drinking water, with levels between ten and fifty percent reduction. Experimental trials consisting of resin with synthesized silver (former research using paralleled silver synthesis methods support this line of work) are in the process of being completed.


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The Effect Of Water Absorbing And Oil Absorbing Polymers

Syed Hasnain

Over the past few decades, oil dependency has risen to its highest ever. And with that dependency, there have been many oil spills that devastate our ecosystems. This experiment was conducted to research how water-absorbing and oil-polymers play a role in the rehabilitation of soil contaminated by these hydrocarbons. These polymers were used to test their effectiveness in helping Brassica rapa grow in contaminated soil. The independent variables were the polymers and the dependent variable was the amount of Brassica rapa seeds grown. The controls were soil brand and type, amount of water, location, and seed species. The contaminated sample that wasn't treated was the negative control and the uncontaminated sample was the positive control. The alternative hypothesis was supported because the oil-absorbing polymers worked the best. P<0.05 so the null hypothesis can be rejected.


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The Effect of Probiotics on the pH Levels of Potomac River Water

Allison Heefner

Probiotics are live microorganisms comparable to the good bacteria found in the human stomach. They aid in digestion, boost the immune system, and correct Irritable Bowel Syndrome. The purpose of this experiment was to find if probiotics can be used to eliminate ecosystem problems concerning the Potomac River such as the overgrowth of algal blooms. Algal blooms are an overgrowth of clumps of algae that grow in pH levels of 7-9; these blooms can be very dangerous because they prevent sunlight from reaching the bottom of the river floor causing aquatic plants to die. The starting pH levels from the river were taken. Four types of probiotics were added to four water samples, leaving one sample without a probiotic. The final pH levels were measured and recorded after 24 hours.

Out of the four test groups, three had a mean pH that was less than its starting pH: 7.26-6, 7.4-7.2, and 7.33-7.2. There was an average decrease in the pH level in these three samples: Sample A had a decrease of 1.26, Sample B had a decrease of 0.3, and C had a decrease of 0.26. The control's pH level, however, increased by 0.2. The results support the original hypothesis that probiotics would decrease the pH of Potomac River water and means that certain elements in probiotics could be used to decrease overgrowth of algal blooms in the Potomac River. An ANOVA F-test yielded a result of \( F(4, 70) = 43.5 \) and a p-value less than .05 therefore rejecting the null hypothesis that probiotics have no effect on the pH levels in river water. Areas of further research could investigate what specific element of probiotics effect the pH level.


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Lumbricus terrestris, commonly known as the earthworm, lives in the soil. While in the soil they aerate it making the soil softer and easier for plants to root into. They also make the soil more nutrient rich when they expose of waste. The purpose of this research was to inform gardeners and farmers of liquids that Lumbricus terrestris are attracted to and repelled by in order to make it easier to get them into their soil. For this experiment, eight solutions were sprayed on a thin layer of soil in eight sections. The procedure included placing sixteen Lumbricus terrestris into the soil and measuring the number of Lumbricus terrestris in each section of the soil after ten minutes. The mean number of Lumbricus terrestris in water was 4.3 and the mean in tea was 1.07 and therefore supports that water was the most preferred by the Lumbricus terrestris and tea the least preferred. The experimental hypothesis that if worms are placed in soil of various liquids, the worms will be attracted to a sugar water mixture was rejected. An ANOVA test yielded a result of $F(7, 112) = 10.4$ and a p-value less than .05 and therefore rejecting the null hypothesis that the type of liquid has no effect on the attraction of Lumbricus terrestris. Further tests could include the attraction of Lumbricus terrestris to heat.


The Effect of Woven Burlap on Soil Erosion

Alisa Malychev

Excess soil erosion depletes soil quality and chemicals are transferred into water sources. Human practices, like excess framing, worsen the problem. In this experiment water bottles filled with soil were placed on their sides and covered with burlap, straw, or nothing. Water was poured onto the soil and the amount of eroded soil was collected. The control group had exposed soil and the constants were the amount of soil, amount of water, and type of soil. The average soil erosion for burlap, straw, and exposed soil was 3.1, 4.5, and 11.7 grams, respectively. An ANOVA test was performed to determine differences among the means (P<0.05). T-tests were completed and determined that burlap and straw coverings held the soil in place and less soil was eroded when compared to the control with no covering (P<0.05). The results supported the alternative hypothesis, “if woven burlap is placed above the soil during continuous water flow, then the amount of eroded soil will be greatly reduced compared to exposed soil or soil with straw.” Burlap worked the best because it is a tightly woven material and is not as displaced as the wheat straw. This experiment shows that woven burlap inhibited soil erosion when used with potting soil, but further investigation could be done to see if it is effective on other types of soil as well.


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The Effect of Insecticide on Dugesia tigrina

Akhil Nallamala

Chlorpyrifos is a pesticide used to kill a disease called Black Sigatoka that appears on banana plants. This pesticide goes into freshwater environments and kills Caiman crocodilus in Costa Rica. The purpose of this experiment was to see how long Dugesia tigrina will survive by varying the amount of insecticide spray. Planaria is a waterworm that has a relatively long life-span and can regenerate quickly. The independent variable was the amount of spray given to each Petri dish; the dependent variable is how long the Dugesia tigrina survived; the control group is Dugesia tigrina with no insecticide sprayed into it. Eleven Petri dishes were set out with five Planaria in each dish. Each dish was sprayed with varied amounts of insecticide except one dish that received no sprays. Groups containing larger amounts of insecticide spray had lower days of survival. An ANOVA test was performed, and yielded a result of $F(9, 90) = 0.017$ with a p-value greater than 0.05 and therefore accepts the null hypothesis that the amount of sprays would have no effect on the length of survival. The alternate hypothesis was if the amount of insecticide spray was increased, then the Dugesia tigrina will have lower days of survival. The alternative hypothesis is supported as the average number of days it took for the control group to die was 0.4545 compared to an average of 0.909 days within the experimental groups. Dugesia tigrina cannot survive more than two days when sprayed three or more times at once.


Carson, R. Silent spring at 50. Massachusetts Ave., N.W.: Cato Institute


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A solution for pollution: Tree-zoning urban forests in Baltimore

Meghana Pannala

Since the advent of the industrial revolution, we have seen a global increase in air pollution. Heavy metal air pollution, a result of industrialization, is known to be harmful to human health. The effects are evident in the city of Baltimore where probabilistic models by the Massachusetts Institute of Technology have estimated that 800 people are likely to die in any given year due to air pollution (Caiazzo, Ashok, Waltz, Yim & Barrett). Urban forestry is a method of mitigating air pollution and these forests and wooded areas improve the air quality of surrounding neighborhoods. The goal of this project is to determine which Baltimore neighborhoods experience the greatest levels of heavy metal air pollution and to model the effect of placing urban forests in surrounding neighborhoods to evaluate the potential reductions of air pollution concentrations. This project has determined the specific neighborhoods within the city of Baltimore that experience the greatest level of heavy metal air pollution by using a modeling environment called AERMOD produced by the Environmental Protection Agency (EPA). A Gaussian air pollution dispersion model was used to predict local concentrations of air pollution using climate and industrial output data. Work on evaluating the impact of the specific placement of new urban forests in Baltimore and surrounding neighborhoods is still in progress.


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The Effect of Different Locations of Elk Lick Run on the Amount and Diversity of Diatoms

Alyssa Rovder

Knowing what is in the water is very important to the ecosystem and humans. Diatoms can be observed to help monitor environmental quality because they absorb dissolved carbon dioxide produced by society's pollution. The problem of this experiment was to determine what parts of Elk Lick Run had more diatoms (algae) which would mean a healthier ecosystem and which did not and why? The three locations that were tested of this stream was North Riding, near the Golf Course, and off of Pleasant Valley. The first 15 rocks with observable algae on them were collected. The rock samples were taken to the lab where a diatom scrub was performed. The diatom scrub allowed a microscope to identify the number of different diatoms that were found on each rock. The IV of this experiment is the different locations of Elk Lick Run: North Riding, Golf Course, and Pleasant Valley. The DV is the number of different types of diatoms and an image of what they looked like. The location with the most vegetation, wildlife, and algae had the largest amount of different types of diatoms, meaning it has a healthier ecosystem compared to the others. This information is important to further research because it can benefit Society and the Ecosystem and find other reasons for healthy and unhealthy ecosystems.


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An Analysis of Biosymmetry as an Indicator of Ecosystem Health due to Hydraulic Fracturing and Landfill Management

Alexandra Sarkis

Hydraulic fracturing is a large threat to environmental health. Not only do harsh chemicals that are injected into shale mix with groundwater as each well is “fracked,” large quantities of methane gas are released into the atmosphere and groundwater. Methane release is also prevalent in landfills. Studies suggest that developmental asymmetry in organisms that are supposed to be symmetrical is an indicator of exposure to stress. Hence lack of symmetry in these organisms may also be an indicator of decreasing environmental health. The purpose of this research was to determine whether chemicals and methane gas produced from hydraulic fracturing sites in Mansfield, PA and the Loudoun County landfill affect leaf symmetry. Leaves from oaks and maples were collected in locations both close to and some distance away from both fracking and landfill sites. Leaves were analyzed for symmetry by measuring vein length on right and left sides of leaves using ImageJ. Statistical analysis via a t-test showed that at fracking sites there was a significant difference in the leaf symmetry of red oaks at near and far locations. Symmetrical difference in red maples was insignificant. At the landfill location, there was significant difference in symmetry in both species of oaks. Further research would entail collecting leaves during the spring and summer growing seasons when initial development takes place. By determining symmetry or lack thereof in organisms growing and living near such sites, recommendations can be made as to whether remediation efforts are needed to protect environmental and organismal health.


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The Effect of Different Concentrations and Adaptation of Eisenia foetida when Exposed to Various Detergents

Lauren Thompson

Compare the toxicity of ecofriendly and conventional liquid detergents using Eisenia foetida, red worms, as test organisms. Determine which detergents are safer and have less of an impact on the environment. If the detergent is more ecofriendly, then more of the worms will survive. The various dilutions of detergent, 3%, 6%, 12.5%, 25%, 50%, and 100% were monitored throughout each of the 5 day period trials. On the last day of each trial, day 5, the number of worms dead and alive were calculated and recorded. The 0% dilution of each series was used as control of the experiment. The worms in this dilution were only exposed to pure water.

Once the dilution series for each detergent, Tide, All, Seventh Generation, and Green Shield, are mixed up properly 100 grams of potting soil were added to each cup. For a total of 28 cups, 7 for each of the different detergents including the dilution series. Then, 4 worms were added to each cup and covered for 5 days. At the end of the 5 days, each cup was dumped out separately to gather data of how many worms stayed alive and how many died for each dilution and detergent. This procedure was repeated twice more to gather additional data.

The more ecofriendly the liquid detergent, the decrease of the pollution rate in the soil resulting in greater survival of the worm population. This states that the more ecofriendly the detergent is then it will have less of a negative impact on the environment due to it containing softer chemicals that aren’t as harsh for the ecosystem. With a P-value of .002, it indicates that the outcome would not have occurred by chance alone.

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Mussels are a key part of naturally maintaining healthy bodies of water because of their ability to filter out chemical pollutants and bacteria, such as E. coli, that could be harmful to other organisms; however, several species of mussels in Virginia are now endangered due to increased amounts of water contamination. The goal of the experiment was to identify which of the three most common chemical pollutants found in fertilizers are the most lethal to mussels. The experiment explored the effects of nitrogen, phosphorus, and potassium-laden fertilizers on the lifespan of the Mytilus edulis by simulating their natural habitat and isolating pollutants. Each trial consisted of four identical tanks containing the same type and amount of gravel, pond water, airstones, and, but rather than having several types of pollutants that are normally present, fertilizers with isolated nitrogen-phosphorus-potassium (NPK) ratios were introduced to three of the tanks. The results supported the hypothesis, predicting that if types of chemical fertilizers were isolated and introduced to the Mytilus edulis, then the group exposed to phosphorus-laden fertilizer would have the shortest lifespan. The P value of the data collected was found to be less than 3.94, supporting its statistical significance. Phosphorus was the most lethal contaminant due to its resistance to reacting with water and other particles, so was able to maintain its original structure and accumulate in the filtration tissues of the mussels, causing them to be unable to obtain nutrients through suspension feeding. Further research could be conducted to understand why most contaminants that are toxic to most organisms can be filtered through the M. edulis without complications.


The Effect of Increasing Carbon Dioxide on Phytoplankton Levels in the Potomac River

Samantha Winn

The purpose of the experiment is to demonstrate how increasing carbon dioxide levels affect the native phytoplankton in the Potomac River. If the amount of phytoplankton decreases too drastically, there will not be enough food for the other organisms that live in and around the river, ranging from invertebrates, to waterfowl, and even to humans. The humans around the area depend on the economic opportunities provided by the fish that survive by eating the zoo plankton, that in turn survive by feeding off the phytoplankton. If the phytoplankton were to disappear, it would cause the whole system to collapse. If the carbon dioxide levels keep increasing, the native phytoplankton levels in the Potomac River will decrease. The independent variable is the amount of carbon dioxide mixed with the water, and the dependent variable is the level of phytoplankton in the water. The greater the amount of carbon dioxide added, the lower the phytoplankton levels in the culture there are. The data collected that was analyzed with pH strips and a spectrophotometer shows a decrease in phytoplankton as well as an increase in water acidity. The P value was 2.19 x 10^-4 using the ANOVA test, which is less than 5%, so the difference between the data due to chance alone is not significant, and supports the hypothesis. If the carbon dioxide levels keep increasing, the native phytoplankton levels in the Potomac River will decrease.

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The Effect of Ocean Acidification on the Mass of Cabomba caroliniana

Joshua Woon

The pH of the ocean is rapidly dropping due to the large amounts of CO2 being absorbed. This is preventing corals and shelled invertebrates from building their calcium-based skeletons and shells at a normal rate. This Project will investigate how this acidification will affect oceanic plants using acetic acid to simulate different pH levels in the water.


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# Mathematical Sciences (1300)

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In 1952, using two reaction-diffusion equations, the mathematician Alan Turing realized that patterns could be generated. Since then, the search for Turing patterns in nature has been largely theoretical due to the great applicability of the equations in a variety of disciplines and the search for defined, quantitative values. These Turing patterns may also exist in predator-prey relationships, but again, there is no evidence or easy process by which scientists can gather quantitative values in order to evaluate and determine whether interactions resemble Turing patterns.

The purpose of the research was to determine whether or not the presence of Turing patterns could be scientifically supported via analysis with a Turing simulation program. Predator-prey relationships between Paramecium and yeast were analyzed via video of the interaction between them to see if predator-prey interactions also produced Turing patterns.

With confirmation of the predictable mathematical pattern that is indeed a Turing pattern; future simulations can be conducted in order to predict the movement of predators and prey in order to assist environmental organizations that are involved in conservations efforts and show that Alan Turing’s equation can be applicable to the interaction of molecules in the natural world. Research is ongoing at the time.


Developing a Unique Model to Predict the Efficacy of a Revolutionary Cancer Therapy

Rachel Burns

HER2-positive breast cancer is characterized by an overexpression of HER2, a growth receptor protein, on the surface of the cancer cell, which increases the rate of cell growth and replication of the breast cancer. Pertuzumab is a chemical which targets and binds to HER2 proteins, resulting in an inhibition of cell signaling, eventually leading to the death of the cell. Ado-trastuzumab emtansine (T-DM1) is an antibody-drug conjugate that not only binds to the HER2 protein and inhibits signaling, but also injects emtansine, a derivative of chemotherapeutic agent maytansine, into the cell following the bonding of the compound to the HER2 protein, thus killing the cancer cell.

Mathematical modeling of breast cancer tumors in response to various treatment regimens of T-DM1 and pertuzumab can provide a cost effective method of analyzing dosing regimens by decreasing the number of clinical trials necessary. This goal is achieved by modifying a previously created integrated model for predicting tumor growth in the presence of two drugs by developing parameter ranges, accounting for differing cell responses to the drugs, and incorporating a multiple dosing regimen. Obtaining exact parameter values and data is currently in progress, which will allow for the confirmation of the accuracy of the model.


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The Effects Of Daily Price And Volume Of A Stock To Create An Algorithm To Predict Future Trends In Stock’s Performance.

Ansh Chaudhari

The stock market can be unpredictable and volatile for investments. By using researched algorithms and statistical patterns, interpreting the stock market might become easier and more reassuring to rely on. This project focuses on using the price and volume data of a stock to interpret and formulate an algorithm, which will indicate the direction the stock is leaning towards. The method used for the purpose of this project was predictive analysis using Coca-Cola Company’s historical data over the last one year’s data to evaluate future performances of the stock. Once the algorithm was completed, it was tested on fourteen companies along with the control over a period of six months to gauge its success rate on the prediction of the performance of the stock. To validate the success rate of the algorithm, it was compared to actual performances of the stock. The test results of the algorithm showed that it did not meet expected levels and did not produce high success ratings for the companies tested. It provided success rate ranging from 43% to 62%, with an average of 52%, but none of which were at proper levels of acceptance (p>0.05). Although it did not produce positive results, the current algorithm could be used as a basis by incorporating other aspects including trend, volatility, and advanced tools and techniques. A further analysis of the occurrences where it did not produce desired results could be made to focus on the weaker areas to strengthen it further.


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The Minimal Amount of Vaccinated People Needed in a Population in Order to Prevent an Epidemic

Shannon Song

In a world of terrorist threat, such as the attack of anthrax on Washington D.C. or the recent chemical weapons attack in Syria, the increasing use of bioweapons is a very real possibility. This project is a scenario model of a simulated attack on New York City, where a smallpox virus (Variola major) is released in the Times Square subway station. The model consists of varying levels of government response to the outbreak, based on vaccination regimens. The design consists of five compartmental labels for victims: Susceptible, Vaccinated, Infected, Recovered, and Dead.

Data Pending

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## Medicine & Health Sciences (1400)

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Genetic Factors that Influence the Rate of Hepatitis C Occurrences in Different Races and Ethnicities

Nour El Hoda Abdalla
Mallika Subandh

An estimated 3.2 million people in the United States are living with chronic hepatitis C infection. Approximately 75%–85% of people who become infected with Hepatitis C virus develop chronic infection. The purpose of this study is to determine the genetic factors behind the occurrences of Hepatitis C occurrences in various races and ethnicities to find a pattern that could lead to more effective methods of prevention. The experiment was conducted by looking at recent and past data about Hepatitis C (HCV) occurrences in Colorado, New York, New Mexico, Oregon, and Connecticut. The data was then analyzed using a T-test and Standard Deviation. Whites were tested with the highest average of HCV amongst all of the races. It was found that there was a significant relationship between the occurrences of Hepatitis C in people of American Indian/American Native, Asian/Pacific Islander, Black, White, and Hispanic origins across the aforementioned states. The null hypothesis failed to be accepted. This suggests that genetic factors may contribute to Hepatitis C infections in people of different races.


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The Effect of Headphone Price on Hearing-Loss

Connor Anderson

With headphones becoming a more popular form of entertainment, further health information would benefit many. Thus, the purpose of this research was to determine if any correlation exists between the prices of headphones and possible risks of hearing loss. First, data from a professional audiophile website, Inner Fidelity, was used to calculate the standard deviation of the headphones’ frequency response graphs. As the standard deviation increases, the possibility of hearing loss increases. The possibility of hearing loss was measured this way because Etymotic Research suggested that headphones with undesirable peaks can produce harmful levels at certain frequencies. Next, the prices of the headphones were gathered from Amazon.com. In summary, the correlation test suggested that prices of headphones are somewhat related to possible hearing loss. The regression test accepted the alternate hypothesis that the prices of headphones are related to possible hearing loss by resulting in a p-value < 0.01. Additionally, the correlation test resulted in a negative correlation of 0.5. This shows that overall, more expensive headphones are at lower risk of hearing loss that less expensive ones. Further research on this topic can be done by using the list price for the headphones. Because the list price and actual price of headphones can vary significantly, it made sense to use Amazon.com to find the prices of the headphones. Moreover, additional research can be done using different ways of calculating the risks of hearing loss.

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The Effect of Artificial Coloring, Flavoring, and Sweetener on the Pulse Rate and Activity Level of Lumbriculus variegatus Compared to Natural Coloring, Flavoring, and Sweetener

Aidan Balac

Many people are upset at big food companies for using artificial ingredients in their products that may cause hyperactivity. The purpose of this experiment is to answer the question: Do artificial ingredients cause hyperactivity? To answer this question, this experiment will test the pulse rate and activity level of black worms in artificial and natural ingredients (food coloring, flavoring, and sweetener). My hypothesis is that the artificial ingredients will cause the blackworms to be more hyperactive than the natural ingredients. The pulse rate and activity level was taken at 0 minutes, 1 minute, 5 minutes, and 10 minutes. The most supportive results were achieved when the ingredients were mixed into one solution (one completely natural and one completely artificial). The mixed artificial solution caused the pulse rate and activity level to go much higher than the natural mixed solution. In conclusion, the results that occurred support the hypothesis and give a solid answer to the question. Artificial ingredients most likely cause hyperactivity.

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Training Muscle Fiber Types and Their Effect on Athletic Performance

Isabel Bowman

This project studies the effect of endurance running and sprint training and the overall impact on athletic performance.

The main focus of this experiment was to determine if endurance training would negatively impact a female, young adult athlete's ability to perform well in sprinting and agility. The participants from Group A used training activities that trained both fast and slow twitch muscle fibers. Group B used training activities that trained only fast twitch muscle fibers, and group C used training activities that trained their slow twitch muscles. The athletes that effectively train both muscle fiber types will not experience a performance decline in power, endurance or speed when compared to athletes who singularly train one muscle fiber type.

Each athlete was required to perform both endurance and sprinting activities. The endurance portion defined the baseline pace for the sprint trials. Each participant was timed performing multiple sprints with a standard rest interval in between each repetition. This test cycle was repeated multiple times to ensure consistency. There were minor variances in sprint performance when compared to their baseline time. However, each test group was able to complete all trials without large declines in their performance.

This indicates that athletes that use proper training and fitness techniques are not adversely affected by participation in multiple sports.

This study provides information to help athletes make decisions about which sports they would like to participate in and whether participation in multiple sports would diminish their success.

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The Effect of Amyloid-beta Protein on the Pathogenesis of Plaque Build-up in C. elegans

Belle Brewer

Researchers have previously thought the Amyloid-beta (Aβ) protein to be a harmful component of plaque build-up in the brain; however, it may be an important aspect of the maintenance of brain homeostasis. Curcumin is believed to break-down existing free-radicals suppressing the Aβ protein, while ginkgo biloba supposedly has anti-oxidative effects on Aβ deposits. The purpose of this research was to determine the effect of these substances on Aβ and plaque production C. elegans. Caenorhabditis elegans of both wild-type and CL4176 Alzheimer’s strains were exposed to curcumin and ginkgo biloba for nine days. After the testing period, the percentage of body mass of worms that consisted of plaque was calculated using Image-J. Ultimately, there was no significant difference in plaque development in either the wild-type or the worms that were genetically engineered to have Alzheimer’s disease (CL4176). This lack of differentiation between the C. elegans may support the idea that the Aβ protein functions as a mechanism protecting against toxic forms of plaque when oxidative stress is already abundant in the brain. Therefore, worms that were predisposed to have Alzheimer’s disease (CL7175) may have experienced the possible antioxidant effects of the Aβ protein maintaining brain homeostasis rather than causing the development of harmful plaque. Further research would entail targeting oxidative stress as the initiator of the development of plaque.


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The Effect of Excessive Amounts of Dietary Lipids on the Lymphatic System

Mythri Chittilla

The purpose of this experiment was to determine how an excessive dietary lipid intake, represented by potato chips, affects the lymphatic system. The significance of this investigation was to determine the long term effects of an impaired lymphatic system. Two experiments were done using the same independent variable (IV), which varied the caloric amount of potato chips (0, 100, 200, 300, and 400). In the first experiment, a prototype was built to demonstrate the lymphatic system’s function of collecting interstitial fluid. A grain of rice was placed in a series of tubes and timed to calculate the flow rate. The results showed that as the fat amount increased, so did the time. This means that it takes less time for the lymph fluid to circulate in the human body. In the second experiment, fat was extracted from potato chips corresponding to the IV. Three lipase capsules were added. Lipid chromatography paper measured the products of lipase, fatty acids and glycerol before and after the addition of the enzyme lipase. As the amount of the potato chips blend increases, the enzyme reaction rate decreased. In both experiments the means of the experimental groups were significantly different (P < .05) and both null hypotheses were rejected. The conclusion states that by reducing lipid intake, many diseases can be prevented like edema, stroke, multiple sclerosis, sinus infections, and etcetera. Further research could investigate how the lymphatic system’s immunity could be affected by excessive lipid intake.


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How does the difference in percent body fat among males and females affect the results of a vertical jump test?

Claire Dietrich
Deja Thomas-Kingsberry

It is said that the body composition, specifically body fat, amongst males and females plays a key role in differing athletic performances of genders. The purpose of this experiment is to analyze the association between body fat in males and females and the outcome of an athletic task (vertical jump test). The total body fat percent of 10 females and 10 males was recorded. To determine the total body fat percent, the InnerScan Segmental Body Composition Monitor was used. Each participant was instructed to perform a vertical jump test a total of 10 times each, which was recorded in centimeters. After each participant completed the test, the collected data was averaged and compared to one another. Based on the collected data, body fat and gender have no association with the outcome of the vertical jump test, supporting the null hypothesis. For instance, participant B9 had a total body fat percentage of 8.9 and a jumping average of 49.83 centimeters, however this jumping height was far below participant B8 who had a total body fat percentage of 19.6 and a jumping average of 60.47 centimeters. Also shown in the data, B4 had a total body fat percentage of 20.9 and a jumping average of 33.425 centimeters, while G4 had a total body fat percentage of 21 and a jumping average of 32.862 centimeters, supporting that gender does not factor in the performance of a vertical jump test. These results may be varied due to differing athletic ability and prior preparation, such as warming up.


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Increasing the Effectiveness of Chemotherapy Using Biochanin A

Audrey Francis

Multidrug resistance is a major obstacle in the treatment of cancer. One of the major causes of resistance is P-glycoprotein, an ATP binding cassette transporter that binds and removes toxins from cells, enabling cells to eliminate drugs and toxins before damage is incurred. This study aimed to test the effect of a potent P-glycoprotein inhibitor, Biochanin A, on the efficacy of an anticancer drug called Thapsigargin. Interestingly, it has been found that Biochanin A is able to specifically target cells that overexpress P-glycoprotein, enabling it to increase the accumulation of chemotherapeutic drugs in cancer cells without causing further harm to healthy cells. The nematode Caenorhabditis elegans has been used as an alternative cancer model for certain drugs such as Thapsigargin because it possesses a homolog for a calcium ion transporter that is targeted by Thapsigargin. In this study, C. elegans were used to model cancerous tumors and was treated with Thapsigargin either alone or in combination with Biochanin A. It was found that treating worms with Biochanin A in conjunction with Thapsigargin produced significantly greater reductions in population than Thapsigargin alone, indicating that Biochanin A may be able to improve the effectiveness of chemotherapy and prevent or reverse drug resistance. Additional trials are being conducted to confirm these findings.


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The Effect of Lithium Chloride, Mithramycin, Donepezil, and Memantine Hydrochloride, Either Alone or in Synergy, on Neurological Activity of C. elegans Model for Huntington's Disease

Nicolas Freeman
Dana Kim

Huntington’s disease (HD), an inherited chronic neurodegenerative disorder, destroys neurons with accumulating mutant huntingtin protein in specific parts of the brain, causing cognitive and motor decline later in life. Decreased progranulin protein levels are indicative of HD. Neurological medications including lithium chloride, mithramycin, donepezil, and memantine hydrochloride treat other specific diseases but may also affect HD. The experiment tested whether these medications affect neurological activity and progranulin levels in an HD transgenic Caenorhabditis elegans nematode model. The hypothesis was that lithium chloride, mithramycin, donepezil, and memantine hydrochloride, both alone and in synergy, would increase neurological activity and progranulin levels in an HD C. elegans strain. C. elegans were age synchronized then transferred onto Petri dishes containing the pharmaceuticals. Nematode neurological activity was assayed 24 hours after transfer with the nose touch assay: healthy nematodes locomoted backward from the stimulus while diseased nematodes did not. All HD pharmaceutical groups showed a statistically significant difference (two-tailed p-value less than 0.05) from HD no treatment control. However, all HD pharmaceutical synergistic groups showed no statistically significant difference (two-tailed p-value greater than 0.05) from their respective pharmaceuticals used independently. Progranulin levels were compared among HD and N2 wild strains using an ELISA test kit. Results are pending. Therefore, lithium chloride, mithramycin, donepezil, and memantine hydrochloride, alone and in synergy, improved neurological activity in C. elegans HD strain, and the hypothesis was supported. Future research includes defining the role of progranulin as a neuro-protectant from mutant huntington proteins.


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The Effect of Protective Pillow Covers and Sunlight on Allergens

Gregory Garnhart

Protective pillow covers claim to protect users against allergens that are commonly found in bedrooms, including dust mites. However, some users have not noticed a difference since the beginning usage of these covers. This allows one to hypothesize that, if pillows and mattresses do not have protective covers, they do not harbor more allergens than those with protective covers or those exposed to direct sunlight. Through testing four pillows, two with covers, two without, results showed that the hypothesis was not supported. Testing involved having two pillows with and without a cover in a lit place, and two pillows in an unlit place, also with and without covers. After six weeks, pillows were taken out of said places, and tested using a home test kit. The results showed that no dust mites were found before or after testing on the pillows with the protective covers. However, pillows without covers showed that there was somewhat of an increase afterwards in dust mites after testing. Results were measured in forms of action needed to protect oneself against being further exposed to the dust mites. Categories included: no dust mites, little to no action required, some action required, and action needed. Pillows without the covers required in little to no action required after six weeks. This is not incredibly significant, however, it is an increase over the results shown by the pillows with the protective covers. The data does not support the hypothesis and shows that the protective covers fight against dust mites.

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The Effect of Different Liquids on Tooth Decay

Simrat Jassal

Soda such as Coke® is a liquid that many people drink every day without realizing how much harm it causes to their teeth. Overtime, soda does a lot of damage to both the outer and inner parts of the tooth. The enamel is the outer and hardest layer and can be lost due to exposure to some liquids. The purpose of this project was to find if soda causes teeth to lose more enamel than water. The independent variable was the type of liquid. The dependent variable was the amount of eroding on the tooth. A tooth was placed in a cup containing Coke® and another tooth was placed in a cup containing water for four days. The mass of the tooth was measured each day at the same time. A T-test was performed and yielded t(28) = .0013, and a p-value greater than .05. The null hypothesis that the type of liquid would have no effect on the amount of tooth erosion is accepted. The mean mass loss of the teeth in the experimental group was 0.5333 grams while the mean of the control group was 0 grams and therefore supports the experimental hypothesis that soda will cause more mass loss to teeth than water. Further research could be done using different liquids such as Sprite® to determine the erosion of the teeth. Sprite is another soda but many believe it to be less damaging to the tooth than Coke.


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The Occurrence Probability between Race and Diabetes

Taylor Jones

The purpose of this experiment was to find if an occurrence probability exists between race and diabetes using data from the 2010 Census. Research has been done before trying to find a correlation between diabetes and vitamin D deficiency, viruses, multiple sclerosis, and cancer. There have been tests done to find a correlation between diabetes and race while this experiment analyzes if an occurrence probability exists between race and diabetes. The independent variable was race. The dependent variable was the occurrence of diabetes. A Chi square test calculating probability of data was performed to find the results of this experiment. The chi square value was 2398001.2 which supports that occurrence is not equal. The original hypothesis states that if diabetes occurrence is affected by race, then there is a low probability of equal distribution among races. The original hypothesis is therefore supported. The null hypothesis that diabetes occurrence has low probability amongst races is rejected due to the chi square value of 2398001.2. There is sufficient evidence to suggest that rates of diabetes occurrence differ among races. Further research could investigate if there is a difference in probability of occurrence between Type 1 or Type 2 diabetes within a particular race. Also, investigation can include how race influences the occurrence of diabetes occurrence and why it contains different probability between races.


Diabetes and Cancer. (n.d.). Retrieved from http://care.diabetesjournals.org/content/33/7/1674.long


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Alzheimer’s disease (AD) is a severe neurodegenerative disease characterized by the buildup and deposition of β-amyloid (Aβ), a neurotoxic plaque. In previous studies, herbs, including Hypericum perforatum, or St. John’s Wort, and Coptidis rhizoma, an herb from traditional Chinese medicine, have been shown to decrease Aβ. This study aims to test if a combination of these two herbs will induce a synergistic effect to decrease β-amyloid neurotoxicity in AD through an increase in cell survival and decrease in β-amyloid plaques. In optimization trials, the study tested a range of concentrations to see which concentration of each herb exhibits the least β-amyloid neurotoxicity. After determining these, the optimal concentration combinations will be tested with the phosphatase assay, which measures cell survival. To test β-amyloid plaques, the congo red assay will stain the β-amyloid plaques red in the cells. The combination treatment on the cells will be compared to the cells treated with only one herb and those with no treatment. Preliminary analysis of the optimization trials indicates an optimal concentration of 0.45% Hypericum perforatum and 0.0001% Coptidis rhizoma. Research is still in progress.


Characterization of the transportation of berberine in Coptidis rhizoma extract through rat primary cultured cortical neurons. Biomedical Chromatography, 22, 28–33. doi: 10.1002/bmc.889


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The Effect of House Held Disinfectants on Propionibacterium Acnes

Joseph Reeves

Many young adults and middle aged people suffer from severe acne worldwide. Although there are many solutions to this problem, although they are expensive. The purpose of this experiment was to see if there was a cheaper alternative to cure acne by using 10% rubbing alcohol, 10% benzoyl peroxide, and 10% hydrogen peroxide and water as a control group. The independent variable for the experiment was the type of solution used to fight the P.acnes and the dependent variable was the amount of bacteria that was killed in culture. The hypothesis for the experiment was that if house hold disinfectants are tested on P.acnes than 10% benzoyl peroxide will kill the most bacterial colonies of P.acnes . Although the hypothesis has yet to be proved or disproved as data is still in the collection. Five plates were cultured for each variable and the control at the end of a three day incubation period the colonies will be counted. A T-test will be used to analyze the mean to see if there is a significant difference between the treatment groups. Once this data is collected accurate conclusions will be drawn as to what independent variable killed the most bacteria. These conclusions will also lead to the creation of new questions that could be tested to further investigate the discovery of new information on the subject.


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The Effect of Body Length Ratio on a Runner's Overall Speed

Natalie Rosas
Courtney Walker

Through recent research, Usain Bolt, the fastest sprinter in history, has shown to have the closest body ratio to that of the Vitruvian man which specifically pertains to the Divine Ratio. The intent of this research was to determine whether female runners’ speed was affected by their body length ratios. The hypothesis of this experiment stated that if a female runner contained a body length ratio closest to that of the Golden Ratio (1.618), then they would run a faster 100m time. Body length ratio was supported by taking head to toe, naval to toe ratio of each subject. Each individual completed six 100m trials over a three day period, completing two trials per day. The averaged times of all six trials were compared among the subjects to identify whether there was a correspondence to the body length ratios. The data collected rejected the hypothesis due to the negative correlation between body length ratio and running speed. Subject A contained the closest body length ratio of 1.59, consisting of a 0.025 difference from the Golden Ratio; however, the fastest average time resulted from Subject B of 15.51 seconds, who exhibited a body length ratio of 1.665 (a difference of 0.047 from the Golden Ratio). Despite Usain Bolt’s correspondence of body length ratio to running time, the fastest female subject did not contain the same relationship. Furthermore, the runner that contained the closest body length ratio to the Golden Ratio did not exhibit the fastest time among the subjects. Consequently, weather, availability, and human error affected the collected data, adding inaccuracy to the results.


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Investigating the Effect of Heat Transfer on Light Therapy

Abhinav Seetharaman

Laser treatment is being employed for several applications including wound healing, bone repair, pain-relief, etc. The basic principle of laser therapy relies on the absorption of photonic energy by molecular photoacceptors (chromophores), leading to a photochemical reaction. This photochemical reaction results in the generation of Reactive Oxygen Species (ROS) and heat, which are known to play a crucial role in laser-induced damage. This study explores the role of specific heat in affecting laser-induced damage. By using the formula, $H = ms\Delta T$ (where $H$ being Heat, $M$ being Mass, $s$ being Specific heat, and $\Delta T$ being change in temperature), it was speculated that a change in specific heat would affect rise in temperature and hence cytotoxicity induced by the laser.

Therefore, the specific heat of different solutions was measured using a calorimeter-like setup. Once the specific heat of different solutions was determined, cells (HaCaT, Human Skin Epithelial Cells and NOKSI, Normal Oral Keratinocytes) were treated with solutions of varying specific heat capacities and assessed in laser damage. It was observed that in lowering the specific heat by using various cell culture solutions, there is a sharp increase in temperature at lower laser doses, leading to increased damage to cells.

Further, a robotic arm is being assembled to characterize the heat dispersion during clinical therapy, with the aim of mimicking manual operator hand motions and helping simulate clinical therapy in further lab experiments.


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The Study of Antibiotic Residue in Meat

May Stevens

The main purpose of this experiment is to show the effect of the rampant use of antibiotics in agriculture animals, specifically cattle. This topic is of interest to me because of the growing controversy around the link between antibiotics in cattle meat and the development of antibiotic resistance in humans. Antibiotic resistance occurs when strains of bacteria in the human body become resistant to the effects of antibiotics. The main cause of this bacteria resistance is the overuse and misuse of antibiotics in humans and animals. This experiment is meant to show the difference in the amount of antibiotic residue in organic vs. non-organic cow meat. The hypothesis is; if an animal is given high amounts of non-therapeutic antibiotics during their life (non-organic), then that animal has a higher chance of having antibiotic residue in their meat. The sample meat were tested with an inspector-grade test called the Premi-test. The test detects antibiotics and sulphonamide residues in meat. I tested 20 samples of meat total; 10 organic and 10 non-organic. I used a meat press and extracts approximately 300 microliters of meat juice/blood and put it into the test ampoules. The test ampoules were then incubated in a 64 degree Celsius water bath for up to 4 hours until the color medium in the agar in the test ampoules changed color. They were then compared to other control samples and a pH indicator. The final results of the experiment was very interesting. All of the organic samples came back negative for antibiotic residue whereas 30% of my non-organic was proved to be positive.

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Enzyme-Linked Assay with Colorimetric Readout and Electrochemical Assay to Detect Cholesterol and a Functionalized Carbon Nanotube Electrochemical Assay to Detect Oxidized LDL

Adriel Sumathipala

Atherosclerosis induced coronary heart disease remains the leading cause of mortality in the United States. Low-density-lipoproteins (LDL), carriers of cholesterol esters, are attributed to plaque-buildup. Current findings indicate oxidized-LDL (ox-LDL) as having a far greater potency to cause plaque buildup. Standard lab blood tests give total blood cholesterol and density based lipid fractions. Such tests are not performed on site, consequently the test is run infrequently. This research aims to develop a cost effective field test for biomarkers of hypercholesterolemia. Three assays were developed: 1. cholesterol samples in phosphate-buffer (PBS) and Triton-X100 was detected with enzymes cholesterol-oxidase (ChOx), horseradish-peroxidase (HRP) and dye tetramethylbenzidine (TMB); 2. electrochemical cholesterol detection with Triton, PBS, ChOx, HRP, potassium-ferrocyanide electron mediator on hydrophilic paper between two graphite electrode pads; 3. native LDL sample oxidized with copper-sulphate and measured with acid-functionalized carbon nanotube working-electrode fed to a commercial glucose-meter for readout. A blue color was observed for samples with cholesterol in assay-1. The intensity of color increased with cholesterol concentrations from 50 mg/dL-400 mg/dL. For assay-2, current increases from control (PBS) ranged from 36µA to 80µA for cholesterol concentrations 50 mg/dL to 500 mg/dL. No detectable reading was obtained for oxidized-LDL assay-3. Cholesterol was detected both colorimetrically and electrochemically. The electrochemical sensor gives quantifiable measures of cholesterol through detected current. Oxidized LDL was not detected. Research continues for oxidized-LDL sensor with sensitive voltmeter instead of glucose-meter and color analysis smart-phone app for total blood cholesterol.


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Investigating the Effects of Vitamin B-Complex on the DNA Damage Repair of Cells with Xeroderma Pigmentosum Type A

Samantha Swamy

Xeroderma pigmentosum is a rare autosomal recessive disease characterized by hypersensitivity to ultraviolet (UV) light. The impaired functioning of tone of the eight genes involved in the repair of DNA – XP-A through XP-G and XP Variant – causes DNA repair malfunctions involving translesion DNA synthesis and nucleotide excision repair. Symptoms of xeroderma pigmentosum include higher susceptibility to sunburn, depigmentation, increased risk of melanomas, and other forms of skin damage. Previous studies have shown that vitamin B-complex protects against the effects of ultraviolet light and reduces ultraviolet damage in healthy skin cells. This project aims to investigate whether vitamin B-complex will perform the same function in cells with xeroderma pigmentosum type A. In order to test the effects of vitamin B-complex on the xeroderma pigmentosum cells in terms of DNA damage, varying concentrations of vitamin B-complex were added to the cells. Cells were then exposed to increasing time intervals of UV light at 302 nm and allowed 24 hours to recover after which a comet assay was performed. Preliminary data and results show that vitamin B-complex has a significant effect on reducing the amount of DNA damage present in cells with xeroderma pigmentosum type A upon exposure to UV light. Work for this project is still in progress.


Gilljam, K., Muller, R., Liabakk, N. & Otterlei, M. (2012). Nucleotide excision repair is associated with the replisome and its efficiency depends on direct interaction between XPA and PCNA. PLoS ONE, 7. doi: 10.1371.journal.pone.0049199

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An Analysis of Environmental Stress on Antibiotic Resistance Acquisition in E. coli

Damian Acorda

Bacterial diseases are responsible for a large portion of illnesses in modern society. These diseases become more deadly over time, due to the resistance to antibiotics they develop due to constant use of antibiotics to combat current diseases. The purpose of this research was to determine whether the rate of formation of resistance to antibiotics is affected by environmental stress. Samples of Escherichia coli were cultured in different conditions such as 5.0 and 9.0 pH levels, as well as 25°C and 41°C. These cultures were then plated with disks of ampicillin at set intervals to determine the rate at which the cultures became resistant to the antibiotic.

It was found that environmental pressures play a role in the acquisition of antibiotic resistance. Statistical analysis via a t-test indicated that significant acquisition of antibiotic resistance occurred when bacteria were exposed to an environmental pH of 5.0 as opposed to that of 7.0 and 9.0. In addition, antibiotic resistance was most significant in temperatures of 41°C as opposed to 25°C and 33°C. Further research would entail an exploration of these environmental effects on other infectious species of bacteria and their acquisition of resistance to antibiotics. Accurately modeling the acquisition of resistance could assist the medical profession in monitoring conditions favorable to the development of antibiotic resistant strains.


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The Effect of Dog Saliva and Topical Antibiotics on Bacterial Growth

Julia Cline
Abigail Downey

Saliva is a vital aspect of the mammalian body. There has been speculation that canine saliva possesses healing benefits when applied to surface wounds. This is due to a combination of enzymes, proteins and growth factors found naturally in saliva. Common topical antibiotics can be overused and expensive, while saliva is readily available and therefore may present an alternative option. The hypothesis of this experiment was as follows: If dog saliva and various concentrations of topical antibiotics are individually placed in an environment with bacteria, then the topical antibiotics will more effectively prevent the growth of the bacteria than the saliva; however, the dog saliva will still prevent a substantial amount of bacterial growth. To test this hypothesis, Escherichia coli bacteria was cultured in 20 petri dishes, each divided into thirds and labeled accordingly, for one day in an incubator at 37°C. Fifteen sterile discs were saturated with each of the independent variables; Neosporin (concentration of neomycin sulfate 3.5 mg/g), Vitacilina (concentration of neomycin sulfate 5 mg/g) and canine saliva (collected on wax paper) and then placed in the corresponding petri dishes. All twenty petri dishes were placed back into the incubator and the zones of inhibition were measured in millimeters at the same time every morning for a week. According to an ANOVA test, there was no statistical difference between the three treatments for the first 72 hours; however, after 48 hours there was a wider spread among the data sets. After 72 hours saliva degraded rapidly while the antibiotics gradually decreased. This was due to the antibiotics being gels and breaking down to diffuse over time while saliva, a liquid, broke down more quickly. This indicates that saliva is as effective as topical antibiotics at preventing bacterial growth for the first few days.


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Germs are spread from people touching the same surfaces. Many infections are resistant to the strongest antibiotics, and have the potential to evolve into super bugs. Scientists have recently discovered that some surprising surfaces are capable of destroying bacteria on contact. If these surfaces could be recreated, they could be used in hospitals and other high-touch places to prevent the spread of infections. The surface variables studied were cicada wings, the man-made product Sharklet, copper, and paper. The unique procedure used to study and measure the bacteria inhibition of each of surface was to place surface discs into an overnight culture of Escherichia coli K-12, to move contaminated surfaces to prepared Petri dishes, to incubate the Petri dishes at 37° C for 24 hours, and to examine the resulting bacterial inhibition of each surface. A scale of 1 to 10 was used to rate the amount of bacteria on each surface after 24 hours. The mean for the amount of bacteria found on each surface was calculated. The control (paper) had the highest average of bacteria, and the cicada wings had the lowest average of bacteria. These results did not support the hypothesis, that copper would inhibit bacteria the greatest. Recently, a new technology called Gorilla Glass, has been shown to inhibit bacterial growth on surfaces. Corning, the company behind this technology, has embedded ionic silver into the glass of smart-phones. Further research could be performed to compare the bacterial inhibition of this new technology to that of cicada wings.
The Effect of Lactobacillus acidophilus on the Ability of Penicillin to Treat Micrococcus luteus

Mary Douglas

When penicillin and many other antibiotics are taken, they upset the balance of bacteria that naturally live in the digestive tract. Probiotics are used to prevent or treat antibiotic-associated diarrhea by restoring the good bacteria to balance the harmful bacteria in the intestines. There is not much known about the side effects of taking probiotics, alone or with antibiotics. In the case of patients who had weakened immune systems, there have been cases of serious infections when these patients took probiotics to treat antibiotic-associated diarrhea. The purpose of this experiment was to find if the probiotic, Lactobacillus acidophilus, has an effect on the ability of Penicillin to treat Micrococcus luteus. The Micrococcus luteus and the Lactobacillus acidophilus bacteria were plated on control plates and then transferred to test plates. Using a disc dispenser, 6 discs of Penicillin were placed on each of the 20 test plates. The clear zones around each of the antibiotic discs were measured. The data shows that there may be a relation between the effectiveness of penicillin and the use of Lactobacillus acidophilus; however, data continues to be collected.


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The Effect of Commercial Face Washes on Bacteria

Anne Dunlap

Acne develops when there is excess oil on the face. Oil blocks the dead skin cells and causes pimples. Many face washes that are available to teenagers without prescriptions are not what that individual specifically needs for their acne. To formulate a non-prescribed face wash, dermatologists must generalize how they make the solution to impact the bacteria on the face, without being too harsh on the skin. The purpose of this experiment was to find which of the two face washes was more effective at stopping the bacterial growth. The independent variable was the two commercial face washes, Daily Pore Cleanser™ and Blackhead Eraser Scrub™. The dependent variable was inhibition of Escherichia coli bacteria. A sterile disk was dipped in a set of solution and placed onto the plate of agar and bacteria. After 48 hours in an incubator at 37 degrees Celsius, both sets of bacteria plates containing the disks of solution had the same results as the control; no inhibition rings were on the plate.

A t-test yielded a result of t(54) = 5.43, with the means for each group being 0 mm and accepts the null hypothesis that face wash has no effect on the inhibition of bacteria. The results showed that Escherichia coli, found in the intestines of the stomach, was not effected by face washes and therefore rejects the alternative hypothesis that the Black Head Eraser Scrub™ would cause more inhibition rings than the Daily Pore Cleanser™. Another experiment that could be conducted on this subject would be to substitute Escherichia coli for bacteria that would be found on the skin, such as Propionibacterium. This new research could expose the face washes’ effect on bacteria more directly, and would need to be conducted in a lab with a higher safety level.


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The Effect of Eco-Friendly and Non-Eco-Friendly Soaps and Disinfectants on Microorganism Growth

Justin Fox

In the study of the effect of eco-friendly and non-eco-friendly soaps and disinfectants on microorganism growth proved many things about “green” products. The reason behind the conducting of the experiment is the fact that large companies release “eco-friendly” products for more money than the normal “non-eco-friendly” products. The products they release have little to no evidence or research done behind them to back the “eco-friendly” name. The “eco-friendly” products were placed hand and hand with their “non-eco-friendly” counterparts in the same situation of growing microorganisms. Two tablespoons of each of the products were placed into separate jars. Each jar contained the same amount of hay and pond water and were given two drops of milk for nutrients the day the hay and pond water were combined into the jars. In the beginning of the experiment, it was thought by the average consumer that the eco-friendly products would damage the microorganism’s growth the least. This assumption proves to be false however after the testing of both the “eco-friendly” and “non-eco-friendly”. While all the products damaged the growing of the microorganisms greatly, neither of the “eco-friendly” or the “non-eco-friendly” soaps and disinfectants had vastly different scores than each counterpart. In conclusion, the effect of eco-friendly and non-eco-friendly soaps and disinfectants on microorganism growth proved that “eco-friendly” products simply do not perform all that much better than the “non-eco-friendly” counterparts, and in most cases still cost more.

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The Effect of Varying Milk Types on Bacterial Growth in Anaerobic and Aerobic Environments

Neerav Gupta
Marie Morales

In this experiment, bacterial growth was tested in varying types of milk. The independent variables included 1% pasteurized milk (the control), soy milk, almond milk, and goat milk. The dependent variable was the percentage of the plate covered in bacteria, examined by using a dissecting scope and a grid, with squares measuring 1cm x 1cm. There were at least 7 trials for each type of milk, in which 3 of the 7 trials were incubated in an anaerobic chamber; the other 4 trials were incubated in an aerobic environment. All bacteria was grown on Tryptic Soy Agar, and incubated at 37° Celsius for 45 hours. After 45 hours, they were examined. Although the growth was not as noticeable, the soy milk in both the aerobic and anaerobic environments showed the greatest bacterial growth, each with an average of 100% of the Agar surface covered. In the aerobic environment, the almond milk showed the next greatest amount of growth with an average of 78%, the goat milk was third greatest with an average of 12%, and the control of 1% milk showed the least greatest growth with an average of 11% of the Agar surface covered. In the anaerobic environment, like the soy milk, the almond milk had an average of 100% of the surface covered. The control group of 1% milk had the next greatest growth, with an average of 33%, and the goat milk showed the least greatest growth, with 32% of the Agar surface covered. This experiment could be improved by performing more trials for more conclusive results and testing for the growth of one specific type of bacteria.


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The Effect of Garlic on Bacterial Growth

Lauryn Helstrom
Colin Mills

The purpose of this experiment is to test how garlic affects bacterial growth. The independent variable is garlic added to the petri dishes and the dependent variable is the growth of the Escherichia coli bacteria. The control group is the petri dishes with no garlic. During this experiment, E. coli were swabbed on 48 petri dishes and garlic was added to 24. Petri dishes were incubated and colonies were counted every day for 4 days. The petri dishes with garlic had more growth than the no garlic group. The mean for bacteria without garlic was 4.417 colonies and the mean for the bacteria with garlic was 7.042 colonies. The p value, from a t-test, was less than 0.002. The alternative hypothesis was, if garlic is added to the bacteria E. coli, then it will inhibit the growth of the bacteria. Both hypotheses, null and alternative, were rejected. The analysis determined that the effect of the independent variable, garlic, on bacterial growth was extremely significant. Garlic affected the growth of the bacteria by increasing the number of colonies grown compared to the control group. Sources of error were the inconsistent amount of garlic and bacteria in each petri dish; limitations in this project were space and time. More trials would have improved the data. Further research could be testing garlic on different bacteria. A new procedure would be to place a single chunk of garlic in the center of bacteria and measure the ring formed of no bacterial growth around it.


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The Effect of Simulated Cell Density on the Hydrogen Production of *E. cloacae*

Cara Herwig

Hydrogen is considered to be the clean burning energy source of the future. Current methods of hydrogen production are not environmentally sustainable. Bacterial hydrogen production would be a viable source if its production capability is augmented. *E. cloacae* is a bacterium that produces hydrogen. It uses a communication system called quorum sensing (QS) to initiate cooperative behaviors such as making biofilms. QS is a system of diffusible signal molecules that allow bacteria to sense their cell density in their environment. This study determines the effect of activators and inhibitors of QS on hydrogen production of *E. cloacae* to discover whether hydrogen production is related to QS. By adding activators or inhibitors to cultures, a simulated cell density can be achieved—lower for inhibitors, higher for activators—to determine whether bacterial hydrogen production is altered by cell densities. Clove oil, alfalfa oil, and grapefruit juice were used to inhibit QS, and an analog of acyl-homoserine-lactone (AHL) was used as an activator. Gas was collected and measured from 0-24 hours and from 24-48 hours for each variable. Data collection and analysis is still underway. It was found that clove oil grown in a 0-24h period produced more hydrogen than alfalfa oil and the control, and the alfalfa oil produced less than the control. In a 24-48h period, alfalfa oil produced more hydrogen than the control. If bacterial hydrogen production is mediated by QS, the addition of QS molecules may be a simple way to increase hydrogen production and provide clean energy for the future.


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Over the past 15 years, the rate of nosocomial infections in hospitals has steadily risen, causing higher health care costs, longer hospital stays, and higher loss of life over the course of treatment. This experiment is designed to test the effect of how changing materials in clinical settings can affect the growth rate of germs on the tested surfaces without additional treatment. In the experiment, the stated hypothesis was that laminate exposed to a germ sample would be more effective at slowing growth than the CDX ceiling board composed to the same germ sample. To test this, 30 5cm x 5cm material samples of both the laminate and the CDX board were exposed to a genetically pure sample of E. coli K-12, and both were left in a contained, room temperature environment for 72 hours. After this time period, each sample was swabbed and swabbed onto an agar petri dish, which was grown in a 72 degree Fahrenheit incubator for 24 hours. After this time period, the number of bacterial colonies on each plate was counted. This process was then repeated after an additional 48 hours to account for the growth rate. The control in this experiment was agar plates exposed to the E. coli sample, and these plates growth was counted at each experimental count. While full statistical analysis is not complete, statistical patterns indicate that the laminate was better at preventing bacterial growth, but not significantly enough to be considered more effective than the CDX board. Error in the experiment, such as possible agar defects resulting from pouring, sample contamination and discrepancies in measurement times prevent this from being fully conclusive, but it appears that changes in materials can slow growth, as long as the correct materials can be found.


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Using Enzyme Inhibition to Declaw Bacteria

Benedict Lenhart

Because bacteria rapidly evolve resistance to modern drugs, antibiotics that function in novel fashions are required to fight disease. This project involves creating antibiotics using sortase inhibition. Sortase are enzymes that anchor surface proteins to bacteria; the inhibition of these enzymes would greatly inhibit the bacteria's ability to infect. The purpose of this experiment to inhibit sortase activity in the bacteria Bacillus pumilus by using haloacetic acids to react with active sites on the sortase enzymes. Bacillus is known to act as a probiotic against Vibrio alginolyticus. In normal circumstance, Bacillus will inhibit Vibrio's growth. However, if Bacillus’s surface proteins are comprised, its ability to combat Vibrio will be similarly affected. My experiment involved the creation of test broths including Vibrio, Bacillus, and one of each of the test chemicals iodoacetic acid, bromoacetic acid, and chloroacetic acid at 100µg/L. A control broth was made containing no chemicals. After the bacteria interacted, penicillin G was used to kill only gram positive Bacillus. The resulting Vibrio populations were plated, and the resulting colonies counted. High Vibrio populations indicated low Bacillus interference, and therefore high sortase inhibition. A Kruskal-Wallis test was run to compare experimental values to the control. The data revealed that iodoacetic and chloroacetic acid tests had statistically significant colony counts compared to the control, while bromoacetic acid was statistically similar. This indicates that while bromoacetic acid’s effect was minimal, iodoacetic and chloroacetic acid were successful sortase inhibitors, which may be contrary to previous research. Future work continues on determining optimum haloacetic acid concentration for potential application as a novel antimicrobial product.


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The Effect of Silver Nanoparticles on the Neutralization of Escherichia coli Bacteria

Madhura Managoli

This experiment was an attempt to find what concentration of colloidal silver terminates more Escherichia coli bacteria. The independent variable was the concentrations of colloidal silver and the dependent variable was the zone of inhibition. The control was the 100% concentrated silver. The solution was diluted into four Petri dishes, then bacteria was spread onto five agar plates. Sterile disks were put into each agar plate after being soaked in the five concentrations. The concentration groups were 100%, 10%, 1%, 0.1%, and 0.01%. The mean for 100% silver solution was about 0.3 mm. The remaining means were 0.17, 0.067, 0.03, and 0 respectively. The original hypothesis was supported since the results of this experiment state that the 100% silver concentration of colloidal silver yielded a larger zone of inhibition than the other concentrations. The null hypothesis was the concentrations of all groups will result in the same amount of zone of inhibition for each agar plate. An ANOVA test resulted in F (0.195, 0.023) = 0.049 and a p-value less than 0.001 and therefore rejecting the null hypothesis. This research supports that 100% colloidal silver may be used to eliminate bacteria since the highest concentration showed significance of the effectiveness in destroying bacteria in comparison to other concentrations. Further research could include testing the efficacy of colloidal silver solution on other pathogens and may be used in deciding the most effective concentration of colloidal silver to be used in medical bandages and other treatments of bacterial infection.


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Which Type of Soap Inhibits E. coli Growth the Most?

Sita Robinson

The U.S. Food and Drug Administration has cited a number of health concerns that appear to be connected to the active ingredients contained in many antibacterial soaps and is pushing the manufacturers to prove their safety and efficacy or will require their reformulation. The hypothesis specifically states that the antibacterial soap containing the largest percentage of active antibacterial ingredients will be the most effective at inhibiting the growth of Escherichia coli. The independent variables for this experiment were the types of soap used, Dial Antibacterial (Triclosan 0.15%), Softsoap Antibacterial (Benzalkonium Chloride 0.13%) and Regular Softsoap. Ethyl Alcohol (70%) was used as the control. Escherichia coli was cultured on prepared petri dishes. The dependent variable was the zone of inhibited growth, measured in millimeters with a ruler. Given the hypothesis, one would predict that Dial Antibacterial soap would be the most effective at inhibiting the growth of bacteria. The results of the experiment indicate that there was a significant difference between the following groups:

- Dial Antibacterial (M=2.45) and Regular Softsoap (M=1.2)
- Dial Antibacterial (M=2.4) and Alcohol (M=1.075)
- Softsoap Antibacterial (M=2.075) and Regular Softsoap (M=1.2)
- Softsoap Antibacterial (M=2.075) and Alcohol (M=1.075)

There was no significant difference between Dial Antibacterial (M=2.45) and Softsoap Antibacterial (M=2.075) The results indicate that antibacterial soaps are more effective at inhibiting the growth of Escherichia coli than regular soap or alcohol. Further research needs to be conducted on effectiveness with different types of bacteria.


Bicks, A. (2007, September 2). Dear earth talk: is it true that anti-bacterial soaps are no better at preventing infections than plain soaps and that they are actually harmful to the environment?.


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The Effect of Bacteria Inhibitors on the Amount of Streptococcus salivarius on a Woodwind Reed

Madeline Sugg

Reeds are used with woodwind instruments like clarinets and saxophones, and are a breeding ground for bacteria. They are played by musicians but are then stored in the dark, warm instrument cases. This experiment tested the most effective way to sanitize a woodwind reed. After exposing the reeds to Streptococcus salivarius, a type of bacteria commonly found in the mouth, hydrogen peroxide, Listerine mouthwash, and rubbing alcohol were used to inhibit the bacteria growth. The independent variable was type of bacteria inhibitor and an untreated reed was used as the control. The dependent variable was the amount of bacteria growth, measured by the number of colonies. The experimental hypothesis was that if hydrogen peroxide was used as the bacteria inhibitor, then the least bacteria would grow. This was not supported, as rubbing alcohol inhibited the most bacteria from growing, with a mean of 1 per reed. Listerine mouthwash was the next most effective, with a mean of 3.5, and hydrogen peroxide, or H2O2, had a mean of 7.3, although this did not account for the size of each colony. The control, an untreated reed, had the most bacteria growth with an average of 30.4 colonies on each. Though rubbing alcohol was the most effective, this experiment pretreated reeds and it would also be beneficial to determine the proper cleaning method for used reeds.


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The Effect of Different Water Treatment Methods on the Survival of Artemia salina

Thomas Suttie

The lack of safe drinking water is a major problem for third world countries, with water borne disease being a major cause of illness and mortality. Safe drinking water is also a concern for hikers and campers in many countries. The purpose of this experiment is to compare the effectiveness of water treatment methods for killing disease causing microorganisms. In the experiment, brine shrimp (Artemia salina) were used to simulate microorganisms in untreated water. Treatment methods used were; boiling, filtration, commercial iodine water treatment tablets and household bleach. The percentage of live to dead brine shrimp was observed in samples treated with the treatment methods and compared to untreated samples. The results of the ANOVA test indicated that the physical treatments (boiling and filtering) were the most effective in killing Artemia salina while the chemicals methods (iodine tablets and bleach) were relatively ineffective. The results refute the hypothesis of the experiment which favored the chemical treatment methods. The experiment itself was limited in that brine shrimp are expected to be an imperfect model particularly for bacterial and viral water contaminants.

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Can you Handle the Dirty Truth?

Maia Tran

Emily VanDyke

The purpose of the experiment was to show amounts of bacterial growth, the type of bacteria, and ways humans can reduce growth. Usually to get rid of or control the amount of bacteria, a bacterial solution would be used. The independent variable of this experiment was the bacterial solution vs. no solution. The dependent variable was the amount of bacterial growth. Lastly, the control group was the group without bacterial solution. Scientists collected bacteria from doorknobs first using solution, then without solution. Next bacteria were swabbed onto petri plates. The dishes were then to be placed in an incubator for 68 hours, and the amount of colonies that had grown was counted. It is important to classify which type of bacteria that were grown. Both the Means and Modes in the experiment were 0, including the control group. The means of the data indicated no growth. The statistical tests that were used verified that nothing had grown. The alternate hypothesis is “if homemade bacterial solution made of water, rubbing alcohol, and white vinegar is used on doorknobs, then the amount of bacteria will decrease compared to the amount of the bacteria on doorknobs without the solution.” The alternate hypothesis was not supported. The IV did not affect the DV. The p value was equal to one so the null hypothesis was accepted. Some major sources that led to error were incubating the petri plates at the wrong temperature: 55 degrees Celsius instead of 37, and swabbing the bacteria too roughly.


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The Effect of Antioxidants on Saccharomyces cerevisiae After Exposure to UV Radiation

Corinne Vennitti

Antioxidants are present in high concentrations in foods such as tomatoes, dark chocolate, green tea, and wine and are claimed to successfully reduce the incidence of cancer. This experiment was conducted in order to model whether antioxidants reduce the likelihood of cancer by using yeast, antioxidants, and UV radiation. For this experiment, UV-sensitive yeast was incubated for two days on YED media-based agar on 15 different petri dishes. The control group was composed of five of these plates and was never exposed to antioxidants before or after UV radiation. The first trial group, another five plates, was yeast exposed to antioxidants before UV radiation. The second trial group, the last five plates, was yeast exposed to antioxidants after UV radiation. Each trial group, after two days incubation, was exposed to three minutes of 285nm UV light, then returned to the incubator for another two days before analyzing the differences in mass (g).

There was a 0.6539g average difference in area between the control and after UV trial. According to the statistical data calculated, the difference in area between these trials was determined insignificant by the calculated t-test value 0.9933. Data for the before UV trial was unable to be collected, therefore the initial hypothesis cannot be completely supported or rejected. This experiment should be conducted again in a timely with the before UV trial, with a larger trial size, varying exposure to UV and use of different types of cells in order to confirm any results.


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## Physics & Astronomy (1600)

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The Effect of Diameter and Weight on the Distance and Accuracy of Flying Discs and Rings

Stephanie Anderson

The study of aerodynamics is what has led to massive machines flying through the sky. The project is to experiment with flying discs and rings and to find which of the disc and rings had the best flight characteristics. This is a simplified way of studying aerodynamics and lift. The disc or ring that flies the most direct course from the launcher will have the best accuracy. The disc or ring that flies the furthest from the launcher will be the one with the greatest distance traveled. The size of the diameter and the weight of the disc or ring is what will determine the results of their flights. The 26cm in diameter, 175g yellow disc was originally thought to have the best flight characteristics as a result of how standard the disc is to Ultimate Frisbee players all over the world. To measure the results of the flight of the discs and rings, a clay pigeon launcher was modified into a disc and ring launcher. This was the constant that ensured each disc and ring was launched with the same amount of force. Each disc and ring's distance and accuracy was measured after it landed. This data was used to determine which disc or ring had the best flight characteristics. The 26cm in diameter, 200g Green Disc had the best accuracy out of all of the discs and rings. The 26cm in diameter, 160g Orange Disc flew the greatest distance. The data for the distance is significant, but the data for the accuracy was not significant.

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The Effect of Nose Cone Shape on Rocket Performance and Stability

Robert Feconda

The purpose of this experiment is to evaluate various nose cone shapes and determine the effect on a rocket’s performance and stability up until the apogee. The hypothesis is that the shape of the nose cone does affect the performance and stability of a rocket. The independent variable in the experiment is the shape of the nose cone and will be the key contributing factor to the test results. The dependent variables in the experiment are maximum velocity, maximum acceleration, and maximum altitude reached for performance; the stability variables are yaw, roll, and pitch rates and stability caliber margins. After testing it was conclusive that the ogive nose cone performed better in actual flight than the conical, short-conical, and cylinder, with an average altitude of 81m, an average velocity of 37.8 m/s, and an average acceleration of 17.9g. All were very similar in stability except for the cylinder nose cone, which had a significantly lower altitude. In the design program used similar results were achieved, but the variance between nose cones was much smaller. It was conclusive that the shape of the nose cone had effects on the rockets performance and stability. Though sometimes minor, each nose cone varied in performance in one category or another. Further research could explore other aspects of a rocket and how they affect a rockets performance and stability both individually and together. The nose cone is only one aspect of a rockets aerodynamics and, though a significant one, does not directly dictate a rockets aerodynamics.

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The Effect of Paddle Size on the Percent Increase of Force

Joaquin Gabriel

The purpose of this experiment was to compare the percent increase of force between paddles of different sizes to find if they are proportional in terms of force. The independent variable was the paddle sizes which were small, medium, and large. The dependent variable was the percent force increase between each paddle.

To execute this experiment, a cable was placed with one end attached to the paddle and another attached to the sensor. The sensor was pulled up along with the paddle and the readings were taken. The results recorded rejected the hypothesis as the average amount of force exerted for the small paddle was 34.814 N, for the medium paddle it was 46.218 N, and for the large paddle it was 48.933 N. The percent increase in force between the small and medium paddle was 33.87% and the percent increase of force between the medium and large paddles was 6.78%. They were not proportional.

The data showed major significance because of the differences in percent increases. The alternative hypothesis that the percent increases of force would not be proportional was supported and the null hypothesis was rejected as a t-test yielded results of $t(28) = 5.28$ and $p$-value less than 0.01. The results supported a greater change in force between the small and medium paddles than the medium and large paddles and therefore supports that paddle size does influence the percent force increase. Though surface area is proportionate, it does not mean that the force input is as well. Further testing could include measuring swim times with paddles.


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How the Angles of a Passer's Body Affects the Accuracy of a Pass in a Game of Volleyball

Emily Haak

How do the angles of a volleyball defender's body affect the outcome of a pass when playing volleyball?

The first thing that young volleyball players are taught is to angle their passing “platform” towards the target. However, they are never taught why they are supposed to do this. As a serious volleyball player and coach, I want to prove that there is a direct relationship between the angles of a player's body, and where the pass ends up.

In this experiment, another player will be used to pass the ball. She will pass the ball fifty times at each of six positions on the court. Out of every fifty passes, five of them will be directed away from the target, and considered “bad” passes. The passer will receive a consistent toss and pass to a stationary target. Three different cameras will be set up from different angles, and the angles of her body will be measured at the point of impact between the ball and her arms. These angles will be entered into a table and averaged, to try and develop a range of angles for a good pass for each body joint affecting where the pass goes. This will be done for each of the six positions on the court. The purpose of the bad passes are to prove that if the body angles do not fit in the designated range, then the pass will not go to the proper position on the court.

The results for this testing will be determined and displayed at LCPS Regional Science Fair.

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The Effect of Fruit Species on Sound Frequency Distortion

Irith Sharma

The purpose of this experiment was to determine if different species of apples will cause different amounts of frequency distortion and therefore relate to sweetness. In this experiment, the independent variable was different species of apples including Red Delicious, Granny Smith, McIntosh, Gala, and Fuji. A sound tone of 1000 Hz was transmitted through each of the apples, and the frequency was recorded after passing through the apple using a computer application that measures the sound waves detected from the microphone. An ANOVA test yielded a result of $F(4, 20) = 1.471$ and a $p$-value greater than 0.05 and therefore accepting the null hypothesis that the type of apple would have no effect on the amount of frequency measured. The tests showed that the Red Delicious, Granny Smith, McIntosh, Gala, and Fuji yielded a mean frequency distortion of 999.838 Hz, 999.966 Hz, 999.99 Hz, 999.918 Hz, and 1000.01 Hz, respectively. The experimental hypothesis that Fuji apples create a higher sound frequency distortion was rejected as the species of apple did not influence the sound frequency distortion. Further research into this topic could explore if specific frequencies, such as the resonance frequencies of each apple, could help determine the sweetness of a fruit.


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The Effect of Different Types of Headphones on Decibel Levels When Different Genres are Played

Kayla Shelton

This experiment was conducted to determine if genres of music have an effect on the decibel levels emitted from headphones. Different types of headphones were tested with different genres of music to determine differences in the decibel levels for each type of headphone in each genre. Different types of headphones (marshmallow, noise-cancelling, and no headphones) were compared with different genres of music (rock music, classical music, and electronic music), and the amount of sound emitted was measured (dB). An iPod speaker was the control group, and the constants were the songs played and the source it was played from. Each pair of headphones was plugged into an iPod and a song that falls into the genre of electronic music was played. Once the song started, the iPod and the headphones were placed in an insulated box that had a decimeter connected to it. When the song was over, the average decibel level was recorded. The mean decibel levels (dB) for marshmallow headphones with classical, electronic, and hard rock music were 31.5 dB, 72.3 dB, and 67.8 dB, respectively. The mean decibel levels for the noise-cancelling headphones with classical, electronic, and hard rock music were 65.2 dB, 82 dB, and 82.2 dB, respectively. The mean decibel levels for the control, no headphones, with classical, electronic, and hard rock music were 49 dB, 77.3 dB, and 78.8 dB, respectively. Significant differences were found between all headphones (p<0.05) when compared except for noise-cancelling headphones. In conclusion, marshmallow headphones reduced noise (dB) the best.


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The Effect of Bat Material on the Distance the Ball Travels

Catherine Troxell

The purpose of this experiment was to determine the best type of softball bat. There are many different types of bats in the bat industry; the ones tested were the aluminum, hybrid, and composite bats. A device was built that "swung" each bat. Each bat was connected to the device and then dropped from 3 feet each trial. Once dropped, a ball was hit off a tee and the distance the ball traveled was measured in cm. Each bat was tested thirty times to give a variety of data. The results showed the average distance for the aluminum bat was 306 cm, 347cm for the hybrid bat and 369cm for the composite bat. After collecting the data and performing the ANNOVA test the data suggested that the composite bat is the best material for hitting long distance. This experiment can help further studies on what materials for bats are safe and what materials are too dangerous. To further explore this topics one can test the effect ball trajectory has on the distance the ball travels.

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The Manipulation of Orbital Debris Using Neodymium Magnets To Prevent Spacecraft Damage

Jack Wagner

As travel between Earth and its nearest celestial bodies becomes more technologically feasible, protection of spacecraft and equipment becomes all the more necessary. As interplanetary activity increases, there is an inevitable creation of debris in Earth’s orbit. Contemporary spacecraft use a simple shield that absorbs the impact of very small debris. The purpose of this research was to improve upon the current shield design by making it more efficient and lighter, using large magnets. Small projectiles simulating orbital debris were shot using compressed air at an array of neodymium magnets. The patterns were then analyzed to see if the magnet array was successful at manipulating the path of the projectiles, concentrating them into a smaller area of impact. Statistical analysis using a t-test indicated that the magnets significantly altered the path of the projectiles. The magnets were able to successfully manipulate the path into a much tighter grouping. When attached to shields, these magnets would require less shield surface area in a real life situation. Further research would entail testing of this shield prototype in a zero gravity vacuum to further increase efficiency and cost effectiveness in space-based equipment.


European Space Agency. 2013. Space debris: assessing the risk. Available online at: http://www.esa.int/Our_Activities/Operations/Space_debris_assessing_the_risk

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Aztec civilizations used biochar as a form of carbon enrichment to make soil more fertile. For this experiment, the Aztec's soil amending techniques will be emulated by mixing in biochar that was burned in a low oxygen environment, to enhance the soil's nutrient longevity. This experiment tests varying compositions of biochar: wood, corn, and no biochar. The three were examined to see if this enrichment does have an effect on the growth of Glycine max (soybean). Throughout this experiment the pH, Nitrogen, Potassium, and Phosphorus levels were tested every ten days to examine the acidity and nutrient uptake. At the end of 60 days, the nodules were counted in order to yield quantifiable data for the growth of the soybeans. Data collected supports the hypothesis; when biochar is present in the soil, nodule growth and nutrient levels rose. It was shown that the soil containing the wood biochar produced a pH level of 7, which is preferable for Glycine max plants, and higher levels of nitrogen that produced a variance for the nodule growth of 32 from the control group (using an ANOVA test). The corn biochar had a pH of 8, the control a pH of 6, and both had low nitrogen levels. For all three experimental groups the Potassium and Phosphorus levels seemed unaltered by the biochar. If scientist can show the large-scale retention rate of the wood biochar, it can impact farmers by providing a safe, inexpensive way to nourish crops as an alternative to chemical fertilizers.
The pH and Productivity of Seagrass Habitats

Alyssa Eversmeyer

Ocean acidification, caused by the dissolution of atmospheric carbon dioxide into ocean water, is a relatively recent trend which, while extremely detrimental to some organisms, may benefit some species of aquatic flora, including seagrasses, which are integral parts of ocean ecosystems. The subsequent increased supply of dissolved inorganic carbon may increase the size and productivity of existing seagrass populations. The purpose of the study is to determine if correlations exist between seawater pH and the productivity levels (defined as the percentages of ground covered or bare, dissolved oxygen levels, and canopy heights) of seagrass populations, using data from seagrass habitats on the east coast of Texas. This data was collected via underwater camera, direct observation, and data sonde by the Center for Research in Water Resources from the University of Texas at Austin. Because the data was not normally distributed and contained many outliers, the Spearman nonparametric correlation test was chosen to analyze the data for correlations between the pH and productivity levels of each measurement location. The Spearman test indicated no statistically significant (p is equal to 0.8243) correlation between pH and seagrass percent coverage, a significant (P is less than 0.0001) positive correlation between pH and dissolved oxygen levels, and a significant (P is less than 0.0001) negative correlation between pH and seagrass canopy heights. These correlations indicate that, with lower pH, the growth of seagrass plants is generally increased, while the level of dissolved oxygen in the ecosystem is decreased, although both of these may be attributable to other environmental factors. The number of seagrass plants in a given area did not appear to be significantly affected by changes in seawater pH. Further research should utilize more detailed data to examine more accurate indicators of seagrass productivity such as biomass and rhizome diameter.


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The Carbon Binge: Can Plants Recover from Sudden Changes in Atmospheric CO$_2$ Level?

Emily Jackson

CO$_2$ levels in Earth’s atmosphere are gradually rising, and it has been found that plants, in response to this, experience significant increases in apparent photosynthetic rate, respiration rate, and biomass. However, it was recently found that plants exposed to a sudden increase in CO$_2$ immediately respond with dramatic decreases in photosynthesis and stomatal conductance (rate of gas flow through stomata). I hypothesize that this effect is due to physiological changes: specifically, changes by the stomata and their regulatory guard cells. In this study, the responses of stomata and guard cells to changes in CO$_2$ level in the short and long term is investigated. It was found that stomatal conductance and stomata density decrease in long-term elevated CO$_2$ level, while stomata size increases. Research is in progress to determine how plants respond to sudden increases or decreases in CO$_2$ level. The results of this experiment will provide insight into plants’ immediate responses to fluctuations in CO$_2$ level, especially due to emissions in areas of deforestation. It is important to understand this since plants are producers of energy, the bottom of the food chain, and a vital carbon sink; if they are altered by manmade atmospheric fluctuations, we must understand how and why in order to alter our habits and ultimately protect our plants.


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The Effect of Molarity on the Water Potential of a Fruit and Vegetable

Shivani Krishnamurthy

Water potential has important biological consequences for plants. It's important for a plant's growth and development since water deficiency can limit a plant's growth and food production. The Independent variable in this experiment would have to be the strength of the different Molar solutions, and the dependent variable would have to be the masses of the fruit and vegetable after each trial. The procedure for this experiment was fairly simple. I measured pieces of apple and potato that were of similar masses, and then submerged them into different sucrose solutions, that had different molar strengths. The most important finding that was shown, at the end of this experiment was that fruits, in fact had a lower water potential than vegetables. Average means showed that there was a lower percentage change in mass within the apple. Also, average means, measured in grams showed the same thing. The average mean, after the apple was submerged in the 0.2 solution was 1.28 grams, whereas the potato was 1.07 grams. My alternative hypothesis was supported by the outcomes of this experiment. The independent variable did in fact influence the dependent variable, which can be seen in the raw data. After water potential genetically modified plants could be looked into, to help crop production.


Department of Biological Science, F. O. (Not Provided). Water potential including biologically relevant properties of water. (Department of Biological Science, 2006)


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The Effect of Magnesium Sulphate on the Growth of Beta vulgaris

Michael Lamana

This experiment was to determine the effect of magnesium sulphate on the growth of Beta vulgaris (Alto beet plant). The 20 pots in the experimental group were treated with 150 ppm (injector rate of 1:200) of magnesium sulphate bi-weekly. The control group was treated with only water bi-weekly for 135 days. It was hypothesized that if magnesium sulphate was added to Beta vulgaris, then micro and macro nutrient content would increase, along with harvested leaf weight. During the experiment the constants were: liquid quantities, soil, temperature and light. The independent variable was the magnesium sulphate. Plants that were treated with the sulphate solution had higher yield and were larger than the plants that received water. After 135 days, tests were conducted using spectrophotometry with Vernier Logger Pro software and LaMotte tissue analysis. All of the 10 experimental groups had elevated nitrate levels; whereas only 1 of 6 in the control had high nitrates. Harvested plant weight was measured with an electronic scale. Average leaf and stem weight was 2.033 grams in the experimental group and 1.4 grams in the control group. T-Tests and Pearson correlation were used for statistical analysis. These experimental results would benefit from additional trials and research. However, the implications from this experiment may indicate that the addition of magnesium sulphate to beet production could have significant economic impact on global yields of a crop that is widely used in livestock feed, chemicals, pharmaceuticals as well as in human consumption and use.


The Presence of the Bacillus thuringiensis Gene in Processed Maize and the Correlation between Genetically Modified Maize Production and the Rate of Colon Cancer

Seerat Mavi
Saloni Singh

The purpose of this research was to identify the correlation between maize production over three (Illinois, Indiana, and Michigan) of the top five maize producing states and the colon cancer rates of those specific states for both men and women. Processed maize products were also tested to see the percentage of which had the Bacillus thuringiensis gene. If the production of maize in Indiana, Illinois and Michigan increases for the years 2006 to 2010, then there would be an increase in the colon cancer rates for males and females residing in those states due to a direct connection between the two factors. Data was collected from CDC and USDA to find the colon cancer incidence rates for both genders and corn production yields by county for each state. By running a T-Test and a Pearson R Correlation, it was concluded that there was a positive correspondence between colon cancer rates and corn production for the state of Michigan as the p values were 0.26 for males and 0.21 for females. While the p values for Illinois were -0.12 and -0.071, for males and females respectively; and Indiana, with p values of 0.016 and -0.057. The result for the latter two states shows that a slightly negative correlation was present between the two factors. However, the averages of the male colon cancer rates were significantly higher than those of the females in all three states. A limitation that constrains generalized conclusions includes the use of only three of the 50 states of U.S. and further research regarding the reasons behind the differences in colon cancer rates between genders along with a broader scope of data is needed to allow for more in depth analysis.


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The Effect of Zingiber officinale on Bacillus stearothermophilus.

Billan Omar

Salt has been the world’s preservation method since ancient times and makes significant life changes to those living in third world countries. However, what if there is another method? Why is salt the only preservation method in service today? This experiment is significantly important to people everywhere, especially in third world countries. So, what is this alternative method? The alternative method could be ginger. Is it possible for ginger, Zingiber officinale, to eliminate or at least suppress the growth of Bacillus stearothermophilus, the main cause for food spoilage? Elimination and suppression of growth will be tested through the zone of inhibition.

To conduct this experiment, aseptic technique was used throughout the entire experiment to lawn the bacteria into 15 petri dishes. Ginger solutions were separated into three categories: 100% ginger, 50% ginger, and the control: distilled water. Blank blotting disks were used to transfer each ginger solution into the designated category labeled on each petri dish. The petri dishes were kept in an incubator at 60-65° Celsius for 72 hours.

Each category labeled on each petri dish contained averages ranging from 0.783 to 0.823 mm. The blank blotting disk is .8 mm in length. This means that my results accepted the null hypothesis and there were no significant changes in growth. The results did not match my prior hypothesis, and the ginger did not hold the capability to eliminate or at least suppress the growth of Bacillus stearothermophilus.


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Investigating the Effect of Various Cytokinin Plant Hormones on the Signs of Parkinson's Disease in the Model Organism Caenorhabditis elegans

Matin Sharifzadeh-Moghaddam

For centuries, natural plant-derived medicines have been used to treat a wide variety of diseases and are still used today as alternative medicines. Cytokinins, a class of plant hormones that promote cell division in plants, have been seen as potential drugs for neural diseases. Parkinson's disease, a neurodegenerative disease causing extreme physical disability, is an illness that can potentially be treated with plant-derived compounds. Parkinson's symptoms are caused by the loss of certain nerves in the brain, resulting in the lack of the neurotransmitter dopamine. Several drugs are available that mask the symptoms of Parkinson's, but do not slow the its progression. The purpose of the experiment was to determine the effects of plant-derived cytokinins on a mutant strain of C. elegans (PINK1) as a model for Parkinson's disease. The cytokinins zeatin, kinetin, and benzylaminopurine were used individually and synergistically to treat PINK1 C. elegans. Age synchronized C. elegans exposed to cytokinins were tested using a "swim-to-crawl" assay. The crawling ability of worms, measured by distance traveled in 3 minutes after transitioning from swimming to crawling, is proportional to the dopaminergic activity in their nerve cells. The results showed statistically significant improvements in the swim-to-crawl assay in the PINK1 C. elegans treated with cytokinins when compared to untreated PINK1 worms. T-tests compared untreated PINK1's to PINK1's treated with each cytokinin, and each had P-values less than 0.05. Additional assays are being conducted to rule out an immediate effect of cytokinins on dopamine release. Further research could determine the mechanism of action of cytokinins in animal cells.


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The Effect of Radiofrequency Radiation from Wireless Broadcasting Devices on the Germination of Vigna radiate (mung bean) Seeds

Shreya Singh

RF radiation is used to provide television broadcasting, cellphones, radios, microwaves, and satellite communications; all of which are just a few of the many telecommunication applications. The experiment shows that common devices that are everywhere today have a negative effect on cell growth. The independent variable was the radiofrequency radiation from the 802.11 WIFI router. The dependent variable was the difference in weight and length of the two experimental groups. The control was the experimental group that was shielded from RF radiation under a space blanket. The mean of the exposed group was 312 g. The means of the shielded group was 555 g. The T-test was conducted. The P value was less than 0.05. The radiofrequency radiation from a device as supposedly safe as a WIFI router has a huge impact on germinating seeds. The difference between the two groups was over 200 grams. The radiation affected the seeds because it rapidly heats and destroys biological tissue. Further research could explore the effect of other devices, like cellular phones and towers, on living cells. WIFI routers were always considered safer than other devices like cell phones, but if they have this large an impact, what kind of impact would the more dangerous broadcasting devices have?


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The Effect Of Increased Exposure To Carbon Dioxide On The Stomatal Density Of Spinacia oleracea

Sorath Soomro

Does continual exposure to increased CO2 have an effect on the stomatal density of Spinacia oleracea. There are many species of plants in the world that might react differently to an increase in CO2; therefore, it is important to experiment on different types of plants for a different reaction. This experiment tested 30 Spinacia oleracea which were grown under controlled conditions. Half of the 30 Spinacia oleracea were exposed to dry ice, which sublimed to CO2, for three hours per day for two months to serve as the independent variable. The other 15 remained under undisturbed conditions as the control. Other than the increase in CO2 concentration, all other factors remained constant. One leaf from each Spinacia oleracea was covered in clear nail polish and the stomatal density, the dependent variable, was calculated by counting the number of stomata per mm2 under a light microscope. The statistics were calculated by using a two tailed t-test assuming equal variances. The mean for the experimental group was 59.9 stomata per mm2, and 122.2 stomata per mm2 for the control. There were significant increases in the number of stomata on the Spinacia oleracea that were exposed to an increased concentration of CO2 (p<0.05). There is a decrease in stomatal density, because the leaves don't need as many stomata to let in CO2 since there is a high concentration of it there. Further experimentation could test the effects of other gases on stomatal density, or test on various different plants.


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The Effects of Soil pH on the CO2 Concentration, Chlorophyll Concentration and Biomass per Ton of Arabidopsis thaliana

Gautam Subramanian

The purpose of this experiment was to test the effects of elevated soil pH of 7.6 on the chlorophyll concentration collected through a spectrophotometer, biomass per ton collected through a balance and CO2 concentration collected through a CO2 sensor, of Arabidopsis thaliana (Mouse Ear Cress). The experimental group of plants was grown in a soilless media (Berger Mix 1 or BM1) to which a 16,340 ppm solution of “Liquid Flowable Limestone F” was applied to raise the pH to 7.6 while the control group was grown in an unaltered media with a pH of approximately 6.1. The independent variable was the lime while the dependent variables were the biomass per ton, CO2 concentration and chlorophyll concentration. With the pH scale being logarithmic, even a small change has significant impact. The t-test indicated that the CO2 concentration and chlorophyll concentration were significantly different but not the biomass per ton because of lack of data. Crops such as beets and corn, widely used for their food, biotech and industrial purposes, have genomes 90% similar to Arabidopsis thaliana. Since significantly raising pH in this experiment indicated decrease in the biomass, etc., it may be assumed that growth in these crops would also be adversely affected by high pH which would affect world crops in areas of high pH soils. Production may be increased by application of sulphur (which lowers pH) or by identifying and disabling or inserting plant genes that respond to changing soil pH. Further research work in this area is needed.


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