Abstracts for the 35th Annual Loudoun County Regional Science & Engineering Fair

March 17, 2016
Freedom High School

Sponsored by Orbital ATK
Loudoun RSEF Categories

Number and Category Name
100 Animal Sciences
200 Behavioral & Social Sciences
300 Biochemistry
400 Biomedical & Health Sciences
500 Cellular & Molecular Biology
600 Chemistry
700 Computational Biology & Bioinformatics
800 Earth & Environmental Sciences
900 Embedded Systems
1000 Energy: Chemical
1100 Energy: Physical
1200 Engineering Mechanics
1300 Environmental Engineering
1400 Materials Science
1500 Mathematics
1600 Microbiology
1700 Physics & Astronomy
1800 Plant Sciences
1900 Robotics & Intelligent Machines
2000 Systems of Software

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. For example project 1303T10 is the third project in Environmental Engineering. The letters, T or X, in the project number indicate whether a project is a Team (T) project or an Individual (X) project.
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The Effects of Illicit Substances on Growth Rate Development of Blowflies in Rabbits

Stephanie Arens
Alexis Nelson

The purpose of this research was to investigate if insects colonized on corpses have a modified growth rate due to the presence of illicit substances taken by the deceased. Then, an analysis of that same growth rate was performed to determine if this provided a more precise cause and time of death. Determining the presence of an illicit substance such as morphine or tramadol is considered highly important as the nation is currently in a drug abuse crisis and these illicit substances could directly affect the postmortem interval (PMI), skewing traditional time of death. This project focused on the growth stage of the Lucilia sericata in relation to the PMI and concentration of illicit substance found in the deceased. With the understanding of entomotoxicology methods, field data of a previous experiment was analyzed. In that experiment, rabbits were administered different amounts of illicit substances, all dosages known to have been fatal for humans, except for R0, which contained no illicit substance. Temperature, a known variable in entomology, was kept carefully controlled as was the weight of the rabbits. The insect studied was then deposited in the eyes, ears, and mouth of the rabbits. Each day, larvae were sampled and measured for growth using both length and width; and the mean value was used for the growth curve. Statistical analysis tests such as the ANOVA and Student T-test were used to determine significant differences between the treatment groups. From the experiments analysis, the determination supported the hypothesis that the presence of drugs does in fact affect growth rate development of insects; therefore, providing forensic scientists a more efficient method of determining if the deceased was under the influence of an illicit substance at or near the time of death.


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Determining Whether Drosophila (fruit flies) Have an Innate or Acquired Feeding Behavior

Carter Atkins
Andrew Fazekas

We don't know whether or not if the feeding behavior of insects is an innate or an acquired trait. We do know that insects have the ability to balance their diet, but we want to find out whether or not their feeding behavior can be influenced to understand if it is an acquired trait or an innate trait. Our hypothesis is; if we make Drosophila (fruit fly) cultures deficient in various medium groups then offer them multiple medium groups to eat including the medium group they are deficient in then, the Drosophila will eat more of the medium that they are deficient in suggesting that they have an acquired trait. We created three Drosophila cultures of each medium, formula 4-24 medium, high protein medium, and high sugar medium. Then we gave each culture the choice of all three mediums to determine whether they have an innate or acquired feeding behavior. We observed that many of the base cultures have clustered around the protein and base medium. The sugar cultures have also clustered around the protein medium. The protein cultures have not been tested yet as many of them developed mold and caused the Drosophila to die. The sugar Drosophila trials primarily ate the high protein medium suggesting that they have an innate trait to correct their diet. However, the base Drosophila also primarily ate the protein medium which suggests that they may be just attracted to the protein medium.


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The main purpose of the experiment is to test the effect of Octopamine on the aggression of crickets in their own community. The experiments being performed will consist of one-on-one interactions, isolation of crickets to test cannibalism, and the effect of octopamine when starving crickets are released into a community of crickets with food. 250 crickets of the Acheta domesticus were experimented on. For the three experiments performed, the independent variable was the octopamine injected, while the dependent variable was aggression observed. Control was crickets without octopamine injections. Crickets were anesthetized, then injected, then isolated until experiment was performed.

The crickets did not demonstrate any aggressive behavior, so there were results. There was also almost no difference between the behavior as the experimental and control groups behavior.

The hypothesis that if octopamine was injected into Acheta domesticus then the crickets would become more aggressive in several settings. This hypothesis was not proven, and there was no proven link between octopamine and aggression. The lack of results show major error in the experiment. For example, the Acheta domesticus is a very non-aggressive cricket, and the Gryllus bimacaltus would have been much better to observe aggression.

Further research could be done on the Gryluss bimacaltus, in which is much better to observe aggression. More research could also be done in giving larger doses to either species of crickets. Also, more research could be done in mixing in chemicals such as chlordimeform, which are known to complement octopamine.


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Enzymatic Digestion of Cryptocaryon irritans’ Exoskeleton: A Cure for Ich

Ashley Carney

Cryptocaryon irritans is a prevalent marine parasite that infects fish. It causes fish to lose color, have trouble breathing, and refuse to eat. These symptoms can quickly lead to the death of the fish. One parasite can reproduce and infect every fish in an aquarium.

The purpose of this research was to determine if protease and/or trypsin enzymes can be used to kill Cryptocaryon irritans by breaking down the exoskeleton of the parasite. Cryptocaryon irritans was taken in the free swimming theront and trophont stages from an aquarium with infected fish. The parasites were placed in jars with saltwater in a temperature controlled environment. In each trial, a control jar had nothing added, protease enzymes were added to the second water sample, trypsin enzymes were added to a third sample and protease and trypsin enzymes were added to the fourth sample. The jars were left 24 hours and the number of living Cryptocaryon irritans parasites in each sample was counted. It was determined that trypsin was the most effective at killing the parasites. Protease was also effective while the application of protease and trypsin together were also effective.

Additional research regarding dosages needs to be conducted before the enzymes are used as a treatment for infected fish. It is supposed that enzymes could be the future of curing marine fish of Cryptocaryon irritans.


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Decomposition rates of human cadavers serve as a missing piece in the forensic community. These types of experiments have minimal data and difficulty with controls when dealing with varying salinity and potential harsh weather conditions. Due to the effects of external conditions, such as snow or excessive rain, the data a research facility can acquire will fluctuate from experiment to experiment. The purpose of this study is to determine if the fluctuations and climate changes correlate in a manner that allows a determination of the relative decomposition rate in a temperate location such as Loudoun County, Virginia. This experiment involves using secondary data from pig cadavers that has been acquired from various experiments. This data has been selected because the tissue very closely resembles that of the human, both anatomically and molecularly. The analysis involves examination of weather conditions and the controls used to protect the cadavers while still allowing some form of natural decomposition to occur. Future experimentation should include analysis of decomposition rates in natural disasters to allow for more accurate postmortem interval determination.


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The Effect of Fire Resistant Clothing on Growth and Regeneration of Planaria

Alexandra Chnyrenkova

Placing fire resistant baby clothing in water with a cut planaria to see the effects of fire resistant chemicals on planaria growth and regeneration. This may provide insight into the effect of fire resistant clothing on child growth and development. The chemicals or polyester fibers may decompose to create harmful residue that will slow the regeneration. This experiment is set to observe the regeneration and the difference of with and without fireproof clothing, and to transfer these results to child development. Spring water from planaria was distributed into five glass cups, pieces of clothing sleeve into the water of four of the cups. Let stand for 12 hours. The planaria were cut directly below the head, 4 planaria per cup. The planaria was observed twice a day (morning and evening) starting the second day. Record activity level, eye presence, alive or not, color variations. Pictures were taken until all have eyes. The analysis the data was done by recording in how many days/ hours the planaria regrew eyes and averaging the four in the plate, as well as their behavior. The hypothesis was rejected since the planaria with the fire resistant clothing had an accelerated regeneration time. This experiment is being repeated.


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The Effect of Activated Carbon and Pesticide on Fruit Flies

Sonali Dawar
Tara Tavakolian

Some pesticides do more than just kill bugs. Some destroy the surrounding environment and can cause problems with the human immune system if inhaled. Activated carbon is known to be a sponge for different chemicals such as the active ingredients found in a majority of pesticides. To test if activated carbon can absorb the active ingredient bifenthrin in pesticide, testing chambers made of water bottles were used. On either side of the chamber were two cotton balls, one soaked in water and one soaked in pesticide. This setup was used for the control. For the experimental part of the project, one cotton ball was soaked with pesticide and the other was soaked with activated carbon and pesticide mixture. The subjects of the experiment were drosophila or fruit flies. The results for the control were as predicted. All the flies in each trial for the control died as they were attracted to the side with the pesticide. Each trial was timed for 15 minutes, and the number of flies that were alive were recorded every 5 minutes. The results for the experimental trial were that a majority of the flies did not die. The activated carbon did in fact absorb bifenthrin. The hypothesis of the project can be accepted. The activated did absorb the bifenthrin enough that when the drosophila came in contact with the cotton ball that had the activated carbon, they were not harmed. Further research could explore if there is a ratio of activated carbon to pesticide that can still exterminate pests but not harm the surrounding environment.


Bansal, R. C., & Goyal, M. (2005). Activated carbon adsorption. CRC press. This journal is about the chemical structure of carbon, and how is changes


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# LCPS RSEF OFFICIAL ABSTRACT - 2016

**The Preference of Pogonomyrmex barbatus: Home or Utopian Colonies**

Gerson Galicia Ortiz  
Miya Washington

The purpose of this experiment was to find how ants would react in a situation where they are separated from their home colony and placed in an improved utopian environment, then reunited with their home colony. The independent variable was the ratio of food given to the population. The dependent variable was the number of ants traveling to the utopia over a certain time. The control group was ants in a colony with the same amount of food as the utopian colony. This experiment used Pogonomyrmex barbatus (red harvester) worker ants. The ants were put into containers for a month and were fed every few days. After a month, five ants were separated into a different colony and were fed every other day for three days. On the fourth day, the two colonies were reunited. The hypothesis, if ants were placed in an improved environment, then the ants would choose the improved environment over their home colony, was not supported because the ants were 88% more likely to return to their home colony. The null hypothesis was accepted because the independent variable did not have an effect on the dependent variable because the p-value from the chi square test was over .95. The error in this project was mold growing in the colonies, ants escaping, and unpredictable schedule changes. Further research could be pursued to study and explore a whole ecosystem with a variety of species rather than just one species.


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The Effect of Ultraviolet Light on Various Life Forms and Their Offspring With the Consumption of Different Types of Antioxidants

Rebecca Hang
Akhiila Kondaka

This project demonstrates the various effects UV rays have on life forms after the consumption of antioxidants. Research has shown that UV rays can cause detrimental and powerful skin cancer. Many antioxidants such as grapes, vitamin E and vitamin C have been known to prevent skin cancer and prevent the spread of it as well. In this experiment, we hypothesize that if fruit flies, cockroaches, and yeast are exposed to grapes, vitamin E, and Vitamin C and then exposed to UV radiation, then the vitamin C will improve the survival rate within the flies. For the cockroaches, vitamin E was beneficial. For the UV stranded yeast, the grapes will prevent the growth of the yeast. The experiment required the use of three different species, fruit flies, cockroaches, and yeast, and three different antioxidants, grapes, vitamin E, and vitamin C. Each yeast specie was equally divided into two sets of four groups to allow for two trials, one with UV stranded yeast and then regular yeast. Each of the four groups were fed the three different antioxidants and the fourth served as the control group. The samples were placed under the UV light one at a time for the same amount of time. Fruit flies, the grapes seems to have increased the survival rate which in turn also produced more offspring than any other antioxidant. The vitamin E showed a slightly lower survival rate than the grapes but higher than normal/the control. The vitamin C demonstrated a reduced survival rate.

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The Effect of Temperature on the Rate of Filtration of Chesapeake Bay Oysters

Jocelyn Hawk

Oysters are an important part of the Chesapeake Bay, as they help filter the water of algae, dirt, and nitrogen. The effect of temperature on the rates of filtration of these oysters can help predict how pollution in the Chesapeake Bay will change over the seasons. This experiment was conducted to determine the effect water temperature has on the rate of filtration of Chesapeake Bay Oysters. Five tanks were filled with five gallons of water gathered from the Potomac River each. One tank was kept at 20°C, one at 24°C, two tanks at 28°C, and one tank at 32°C. Two oysters were placed in all of the tanks except for one of the tanks kept at 28°C. Nitrate levels, general hardness, carbonate hardness, and pH were tested every 30 minutes for six hours. The only dependent variable with a noticeable trend was the nitrate level. The warmer the water was, the more quickly the nitrate level seemed to drop. The pH level fluctuated in each tank, and the general and carbonate hardness dropped at approximately the same rate in each tank. The nitrate level in the control tank did not drop.

http://chesapeakebay.noaa.gov/oysters/oyster-reefs
http://www.cbf.org/about-the-bay/more-than-just-the-bay/creatures-of-the-chesapeake/eastern-oyster
http://www.cbf.org/about-the-bay/issues/dead-zones/nitrogen-phosphorus

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The Effect Of The Volume Level Of Anthropogenic Sound On The Heart Rate Of Daphnia

Hope Kircher

While research proves that high decibel levels of anthropogenic sound, such as naval sonar, have deadly effects on whales, dolphins, fish, and mollusks, it is unknown what effect the sounds have on microscopic organisms. This project studies the effects of varying decibel levels of sound generated by assorted power tools on daphnia, microscopic freshwater organisms, in order to mimic naval sonar and provide information on how oceanic microorganisms are affected. Daphnias' heart rates, the dependent variable, are recorded after being exposed to one minute of 65-110 db of sound, the independent variable, and then compared to a constant group that was not exposed to anthropogenic sound. The heart rates increased by 27.53 beats per minute on average with each increase of approximately 10 db. My hypothesis "If the intensity of anthropogenic sound, measured in decibels, is increased, the number of heartbeats in daphnia in a minute will also increase, because the ultra sound will put stress on the senses and body systems of the daphnia," was supported by these results. The overall increase in beats per minute shows that naval sonar, which reaches levels of 240 db, would give daphnia heart rates of approximately 753.59 beats per minute. This extremely fast heart rate prediction indicates that microscopic organisms are currently being maimed and killed by naval sonar. Further research could explore whether saltwater microorganisms are similarly affected and whether naval sonar has the same effect as the power tools that were used to generate the sound for this experiment.


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Genetically Modifying Zooxanthellae Algae to Prevent Coral Bleaching

Valerie Knowles

Zooxanthellae algae, found inside corals, leave when the water gets 1-2 °C warmer than the normal temperature, killing the coral. Once the corals are dead, the fish leave in search for a better habitat; fishermen will not have fish to catch, tourists will not visit the coastal towns; and it could cause a global depression. There is a way to genetically modify the algae to be heat resistant. In this experiment, the DNA from Zooxanthellae was extracted by lysing the cells with a buffer made from EDTA, HCL, NaCl, SDS, and Proteinase K. The extracted DNA was barely visible until it was suspended in TE buffer. It was concluded that SDS is a crucial material in extracting the DNA; soap will not work as a replacement. The next research part will include growing Zooxanthellae in intervals of warmer water and then using the method to extract the DNA as stated previously. Then the original sample of algae and the ending sample will be sequenced and then compared to determine the genes that changed due to warmer temperature. The samples will then be sent to GENEWIZ (http://www.genewiz.com/) for DNA sequencing. The sequencing information will be entered into the BLAST database (http://blast.ncbi.nlm.nih.gov/Blast.cgi) for analysis. Once the gene is located that controls heat tolerance, it will then be isolated and vectored into the DNA of the control Zooxanthellae by Agrobacterium tumefaciens mediated transformation. The Zooxanthellae will be genetically modified to be heat resistant; preventing coral bleaching.


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Enhancing Survival via Self-medication in Drosophila melanogaster

Louis Montano Arias

Possessing a high tolerance to alcohol gives Drosophila melanogaster the unique ability to survive. Research has shown that when Drosophila are exposed to parasitic wasps, females lay their eggs in areas of high alcohol content in order to increase offspring survival. While wasps attempting to eat larvae will die due to alcohol consumption, larvae survive.

The purpose of this research was to determine if such Drosophila behavior is also present when exposed to other external threats. Drosophila were exposed to E.coli, for 24 hours while insects then were transferred to a container which contained two petri dishes. One petri dish contained Drosophila medium and the other contained medium mixed with a 30% alcohol solution. The number of larvae in each dish was recorded after a week and results were compared to the control. It was determined that the threat and exposure to E.coli did not influence the Drosophila to lay their offspring in the alcohol concentration. Further research would include determining what other aspect in Drosophila behavior influences maternal behavior.


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The Effect of Hydrogen Peroxide Rich Foods on Fungus Infected Ant Colonies

Bryce Pearson
Donal Whelan

Many studies have been performed in order to measure the intelligence of hive insects. They have an ability to act in such a way as to benefit the hive while ignoring individual lives. Members of these species have been observed performing actions that are detrimental to themselves but help the group as a whole. This study set out to demonstrate ant’s ability to do just that: medicate against an infectious disease using a harmful diet choice in order to protect the group. In order to do so, ants were separated into 30 groups of 5 and 15 of those groups were infected with a parasitic fungus. All ants were given a choice between their regular food and food mixed with Hydrogen Peroxide, which is a chemical that is toxic to ants, but kills the fungus. Results were inconclusive, as the ants were dying too quickly from the fungus and from poor laboratory conditions to be meaningfully tested and observed. There were a plethora of sources of error present, from ants that may have already been contaminated with a fungus to other nearby experiments causing side effects in the ants. Further research needs to be done with this experiment in a more professional laboratory with more time, larger samples, and a better supply of ants. Once the original experiment is completed, it would be interesting to see the same type of experiment expanded to other species.


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The Effect of Sublethal Exposure of the Pyrethroid Insecticide Cyfluthrin on Interspecies Aggression and Predation of the Model Organism Lycosidae (Wolf Spider)

Aayush Raman
Kunaal Sarnaik

The purpose of the study was to determine if sublethal exposure to the pyrethroid insecticide, cyfluthrin, would induce a change in wolf spider behavior. Using a double blind study, each spider’s behavior was recorded before and after sublethal exposure to 25 uL of 7.5 ug/mL cyfluthrin. Intraspecies aggression was recorded using the mirror test, in which a mirror was placed in front of each spider and responses recorded. Predation was recorded using the prey capture test.

There was a significant increase in active tracking with the mirror test and increased visual tracking in the prey capture test (Wilcoxon matched-pairs test, P less than 0.05). However, there was no significant difference in visual tracking, and distance away from the mirror in the mirror test, or active tracking and time to capture in the prey capture test (Wilcoxon matched-pairs test, P greater than 0.05). It appears that single-dose cyfluthrin exposure at this concentration has some effect on wolf spider behavior and could possibly increase aggressive tendencies. Data is pending on repeated exposures.

Limitations to the study include the need for a larger group of spiders and repeated exposure. Cyfluthrin has been shown to affect epinephrine, norepinephrine, and serotonin levels in mice and the prolonged sublethal exposure could promote aggression. The literature suggests that continuous exposure could also increase aggression in humans. In order to further the findings of this experiment, other common household insecticides and model organisms must be tested to see if there is correlation between chronic insecticide exposure and changes in behavior.


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The Effects of Aluminum on Brine Shrimp

Emma Smith

The purpose for this experiment was to measure the effects of aluminum on sea creatures. Acid rain contains high concentrations of aluminum and as it gets into the ocean it can lower the PH level causing the water to become more acidic. To test the effects of aluminum on sea animals, three stations of brine shrimp were set up. Group A had .02 g of Aluminum sulfate, Group B had .01 g of Aluminum Sulfate, and group C had 0.0 g of Aluminum Sulfate. The groups each were given the same amount of food and were at a constant temperature. The brine shrimp with aluminum sulfate had a PH of 6 whereas the control group had a PH of 8. Within the first 48 hours of the experiment almost all the eggs were hatched in group C (control), only 3-5 were hatched in group B (.01 g), and none were hatched in group A (.02 g). 5 days into the experiment the shrimp in group C were thriving and growing; 5-7 more hatched in group B, but about 5-6 were dead; only about 3 were hatched in group A, the rest were in dormant cysts. These trials have shown that overtime aluminum does effect the life span of Brine shrimp.


University of Utah, The brine shrimp life cycle. (n.d.). Link- http://learn.genetics.utah.edu/content/gsl/artemia/ This website talked about Brine shrimp life cycles

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A More Ecological Approach to Preventing the Airborne Spread of Bordetella bronchiseptica

Lauren Smith

This experiment was conducted to find a safe, effective method to prevent the airborne spread of Tracheobronchitis, Kennel Cough, (canines) and Bordetellosis (felines) in a kennel environment. The diseases branch from the bacteria, Bordetella bronchiseptica (Merck, 1995).

To test the method, a model organism, E. Coli K12 was cultured in twelve 9 mL nutrient broth tubes and then mixed in a spray bottle. The liquid bacteria was sprayed through an airflow system onto a petri dish to mimic the dog’s cough. The independent variables included bleach and UVC light. The bleach trials involved spraying a 1:32 bleach to water ratio (shelter protocol) in an air vent after misting bacteria (UC Davis, 2016). The UVC trials incorporated a UVC light in the air vent while bacteria was misted. The control group sent bacteria through the vent without added variables.

The results were calculated by recording the colony count of the petri dishes. For trials in the UVC group, none of the petri dishes had bacteria growth. The bleach group included an average colony count of 378.684, and the control had a mean of 1281.12. Data was analyzed using a t-test with control compared to bleach, bleach to UVC, and UVC to control (NCS, 2016).

For all three comparisons, p value was less than .05, rejecting the null hypothesis. Thus, all data was significant with little error. As well, results show that UVC is a less toxic and more effective airborne bacteria elimination method than bleach.

This experiment can be further examined by testing the same process on Bordetella bronchiseptica rather than a model organism. In addition, it could be further tested in animal kennels by inserting a UVC bulb in the air filtration system to potentially offer a kennel alternative to bleach.


UC Davis Koret Shelter Medicine Program. (2016).


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Evaluating the Existence of False Positives in the Classical Conditioning of the Parasitic Wasp Nasonia vitripennis as a Cancer Detection Method

Heather Waters

The parasitoid wasp Nasonia vitripennis has a heightened sense of smell far beyond that of a human, enabling them to detect and differentiate between various volatile organic compounds (VOCs) that can be found on anything from the human breath to food sources. Certain cancer cells also emit very specific VOCs to their environment. Previous studies have determined that honeybees can detect cancer VOCs, but Nasonia are just as capable of detecting and differentiating among scents as honeybees, creating a safer alternate option in cancer detection. However, this method can possibly be prone to false positives. In order to evaluate the existence of false positives, the wasps were divided into three groups of twenty individuals. Each group was exposed to one of three different scents: cyclohexanol (a VOC associated with breast cancer cells), pinacolone (an isomer of cyclohexanol), and a blank control. The Nasonia were conditioned five times by being rewarded with a sucrose solution. In acquisition trials, Nasonia were released into a T-shaped olfactometer with one scent on each end, and their behaviors were monitored in order to determine which scent they preferred. Following data collection, the separate groups of Nasonia were analyzed using a Mann-Whitney to determine whether there was statistical significance between the responses to cyclohexanol and pinacolone, to determine their tendency toward false positives in this means of cancer detection.


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## Behavioral & Social Sciences (200)

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The Displacement of the Mountain People into Mental Hospitals during the Creation of the Shenandoah National Park

Anne Begley

On February 24, 1924, the creation of Shenandoah National Park was authorized, resulting in the relocation and removal of hundreds of families from their land for the sake of creating the Park. Around the same time, the Sterilization Act of 1924 was passed in Virginia legalizing the sterilization of those diagnosed with mental disorders or considered incompetent. This was done without direct consent from the patients in attempt to prohibit their “damaged” genes from being passed on to the next generations. Records of those owning the land wanted as part of Shenandoah National Park and admission records of those placed in Virginia mental hospitals and sterilized via recommendation and review from social workers with whom park officials had collaborated were used to create a definitive list of names of certain people that lived on potential Park land who were placed in asylums. Doctors then legally performed sterilization procedures on these patients without legal repercussions. Noted specifically in Madison County, Virginia, sterilization of individuals from the Park often discontinued the lineage and family heritage of these mountain people without approval or verification of the legitimacy of actions and procedures.

Future research would entail additional analysis of records from remaining counties comprising the park. This information would provide family members with the authentic story of their history and would clarify the methods of creation for certain areas of Shenandoah National Park.

Western State Hospital. (NA). Records of Western State Hospital. 31030, 31353, 31704, 32451, 41253, 41283, 41404, 44812, 45553, 50576, 50989. 1825-2000.


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The Cemeteries of Shenandoah: The Use of GIS In the Preservation Of Cultural Resources

Abigail Brewer

In the 1930’s, during the creation of Shenandoah National Park, over 500 families were relocated. These families were forced to leave their homes and family cemeteries behind. Few records were kept regarding the location of the cemeteries and many of the directions to them were passed down verbally through families. Today, the location of many of these burial sites are not public knowledge.

The purpose of this research was to determine whether ArcGIS could be used to map cemeteries within Shenandoah National Park to preserve historical and cultural resources. Information regarding families who were displaced was collected in order to determine where old home sites and cemeteries were located. Using this information, locations were hiked to and the latitude and longitude of each site was pinpointed using a GPS device. Data collected was entered into Microsoft Excel then geocoded in order to display sites as X Y data on a basemap of Shenandoah National Park.

Finding family cemeteries within the Park is difficult but possible and this difficulty will increase as generations pass unless the location of each site is recorded. As cemeteries disappear, so does part of America’s past. Using geospatial science to record sites helps to preserve a cultural resource and make the cemetery locations more accessible to future generations. Further research would include finding remaining cemeteries whose locations may not be noted to create a geoform in order to make information regarding cemeteries more easily accessible.


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Technology's Effect on Perceiving Emotions Based on Gender and Age

Camila Cifuentes

As technology increasingly becomes an active part of everyday life, it is unknown whether it is inhibiting the ability for people to accurately identify emotional expressions. In this experiment, the use of micro expressions were used to measure the correlation between the gender and age of the participants (independent variable) and the time it takes to identify emotional expressions (dependent variable), in relationship to the amount of technology a participant of a certain age or gender are exposed to. The amount of technology exposure per age group was measured by distributing surveys that asked for their age, gender, and estimated time of technology use per day. The participants were then asked to match the micro expressions, to one of the 7 universal emotions. The participant groups were divided by gender and age (27 males and 29 females, age categories 8-9, 10-11, 12-13, 19-22, and 34-47). No statistical significance was found when separately comparing the average accuracy rates between the males and females of the different age categories; however, greater statistical significance was found when combining the results from the different genders and separately comparing certain age groups to one another, as well as comparing the averages of different age groups to ones of the same gender. This was specifically demonstrated when combining the males and females of the (8-9) and (19-22) age categories, which resulted in a P value of .0001. These results supported the alternative hypothesis that the older participants would score higher percent accuracy scores. Given more time, I would test a greater number of participants and more age groups in order to gather a greater representation of the population.


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Investigating the Movement of Suspected Gang Crime in Northern Virginia

Nicholas Haeff

Since the 1950s, both Loudoun and Fairfax counties have experienced exponential growth, from a combined population of approximately 125,000 in 1950 to approximately 1.5 million in 2014. Several studies have shown that higher populations lead to both higher amounts and higher rates of crime, and also high immigrant populations lead to increased gang activity. It was hypothesized that crime would be seen to be spreading from certain clusters in both Loudoun and Fairfax County. A Java program was written that parses public crime data from the Spotcrime.com website, and then stores the data in an Oracle database. Each year of crime data was plotted onto an ArcGIS map. Clusters of data were identified and the mean squared distance from the center of each cluster was calculated. An ANOVA test was run, comparing each year separately to determine if there is any statistically significant change in the mean distance from the cluster center to demonstrate if either the center of suspected crime was moving, if the center was remaining the same, or if the crime was spreading further out from the center.


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The Negative Effects of Technology on Sleep Patterns

Susanna Janney

From social media to Netflix, technology has become a pervasive part of human life. The excessive amount used in a day already has effects on social behavior, but can technology affect people physically? Studies have shown a decrease in sleep over the past decade, and research has also shown an incline in the use of technology. Doctors believe there may be a link between sleep deprivation and an overuse of technology, however there has been an absence of scientific research in this area. The purpose of this experiment is to test whether technology has a negative impact on the quality and quantity of one's sleep. Subjects ranged in age from thirteen to sixty and were collected from the Loudoun Valley Community. Subjects were asked to monitor their technology usage before bed using the application Sleep Cycle; Sleep Cycle tracks movement in the bed. Subjects were asked in addition to record the data, such as duration of sleep, sleep efficiency, and the sleep phases in their logs. Subjects were asked to track the type and amount of technology they used in the four hours prior to sleep. The data was then collected and analyzed. Generally observing the data, it showed subjects who used more technology before bed typically had an overall worse sleeping experience. Depending on the subject, technology seemed to have either a negative effect on sleep duration, sleep efficiency, or the ratio of light sleep to deep sleep. Further evaluation of the study will be completed to determine the overall results of technology use on one’s sleep.


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The Effect Of Delay between Traumatic Events on the Expression of Post Traumatic Stress Disorder Like Symptoms Using Drosophila melanogaster as a Model Organism

Alexander Johnson
Charles Sterling

Post traumatic stress disorder (PTSD) is a psychological disorder affecting 6.8% of Americans over the age of eighteen. It can manifest itself in many ways, often forcing sufferers to re-live previous traumas when exposed to similar or reduced stimulus. The goal of this project was to determine if the delay between traumatic events has an effect on the rate of expression of post traumatic stress disorder. This was tested using Drosophila melanogaster as the project’s model organism. The Drosophila were traumatized using vibrations (simulating a predator walking nearby) or shadows (simulating a predator) with varying intervals between trauma. Control groups of Drosophila did not undergo this initial trauma. After 15 minutes and after 24 hours, the Drosophila’s response to lesser trauma was measured in time spent frozen.

There was no significance difference between experimental groups and the control group (Kruskal-Wallis, P>0.05). The main limitations to the study were the small number of Drosophila and problems recording the flies, which resulted in a small dataset. Though no concrete conclusions can be made from this experiment, the question of the project remains relevant in the prevention of PTSD in those currently facing traumatic events, from firefighters at home to soldiers abroad.


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Flow Analysis of Crowds Movement: Mapping Safer Egress and Regress

Lauren Kane

Two hundred fifteen human stampedes occurred between 1980 and 2007. This resulted in over seven thousand deaths and fourteen thousand injuries. These fatalities were primarily due to asphyxiation or crushing. The purpose of this research was to propose potential solutions to human stampedes and other crowd disasters to prevent injury and death. Analysis of the Hajj stampede of 2015, the Los Angeles riots in 1992 and the Baltimore riots in 2015 was conducted and the software, Pedestrian Dynamics, was used to model simulations of these real-life situations to suggest possible solutions. For example, to accommodate the millions of pilgrims that travel to Mecca during the Hajj, Saudi Arabia constructed the $1.2 billion dollar Jamarat Bridge. The bridge features automated foot traffic controls, video monitoring and surveillance technology. However, for many developing countries that do not have funds for such projects, there are simpler, more cost-effective solutions. Increasing the number of access points and instituting stricter traffic control at bottlenecks is imperative. In areas such as Baltimore and Los Angeles, where infrastructure is fairly permanent, law enforcement officers should try to direct the flow of traffic to wider streets by blocking off smaller side streets and alleyways. Attempting to centralize the crowd onto a larger main road can help to limit damage and fatalities. Despite the research already completed, additional flow analysis of human movement is needed to improve the collective understanding of the causes and how to prevent them.


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An Exploration of Crystallized Intelligence via Memory Recall

Prachi Punit

Memory recall, or memory retrieval, refers to the re-accessing of events or information from the past that have been previously encoded or stored in the brain. During the action of “recalling”, the brain replays the pattern of neural activity that was originally generated in the response to the particular event and reiterates the brain’s perception of the real event. The purpose of this research was to determine whether crystallized intelligence, the ability to use skills, knowledge, and experience, correlates with age. Participants tested were from a pool of students, ranging in age from 17-18 years and senior citizens ranging in age from 70-100 years. Participants were given one-minute intervals to memorize seven pictures. The first test used the free-recall method and participants were asked to recall the images in no particular order. The participants used the ordinal-recall method for the second test to recall the images in a certain order. The final test was used to recall major monuments and locations which tested crystallized intelligence. It was determined that with age, memorization skills decreased in regards to crystallized intelligence. The younger participants tested were more readily able to recall images as well as identify monuments and their locations. Further research would entail testing individuals from various age groups with more detailed tests to determine what equips them to recall events stored via crystallized intelligence and why younger individuals are indeed more equipped to recall via long-term memory.


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The Effect of Artificial Sweeteners on a Model of the Digestive System

Rashmi Bojja
Sanika Gupte

Artificial sweeteners have shown to cause diseases like inflammatory bowel disease (IBD). The purpose of this experiment was to test if artificial sweeteners would change the acidity of the stomach environment affecting the gut flora and inhibiting the enzymes that metabolize sugars. The mean values of the independent variables for the change in temperature for Splenda (Sucralose), Sweet N’ Low (Saccharin), Equal (a mixture of aspartame and acesulfame potassium), table sugar (sucrose), and negative controls were 1.70, 2.20, 1.90, 0.350, and 0.350, respectively. The mean values of pH for Splenda, Sweet N’ Low, Equal, Sucrose, and negative controls were 1.63, 1.73, 1.33, 2.00, and 2.17, respectively. Two separate Analysis of Variance (ANOVA) tests were conducted for temperature and pH to test the independent variables: Sweet N’ Low, Equal, Splenda, a positive control (sucrose), and a negative control (containing no sugars). The ANOVA test for temperature yielded a p-value less than 0.05. The ANOVA test for pH resulted a p-value less than 0.05. Therefore, the null hypothesis, artificial sweeteners have no effect on the model of the digestive system, was rejected. The experimental hypothesis was accepted as the artificial sweeteners had significant change in pH and temperature. Further research can be done to test how the changed stomach environment affects gut flora and the health of people consume these products.


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The Concentration of the Dialysate for Optimizing Blood Purification in Dialysis

Amber Lee Curran
Mariana Escalante

The composition of the dialysate effects renal patients going through dialysis. It effects cardiovascular stability such as variances in blood pressure, a disequilibrium of ionic fluids leading to symptoms such as fatigue, muscle cramps and headache. Potassium and Calcium concentrations preform a role both in myocardial contractility and in peripheral vascular resistance. Increasing or decreasing the concentration of these ions will assist in the optimal function of dialysis for patients. Acid-buffering by means of base supplementation such as Bicarbonate is one of the major roles of dialysis. The full role of concentration of these compounds in dialysis is still undergoing discussion. Standard dialysate solutions in optimizing blood purification can vary with each individual and their physical needs, but there are boundaries of functional optimal success. This study examined the concentrations of the dialysate for optimizing blood purification in dialysis. The means of concentration effective dialysate for this study was 1.9 M potassium and 1.54 M for Calcium. Other consideration for expansion of this study would deal with specific requirements such as patients’ management of renal bone disease and simultaneously reducing cardiovascular disease.

Locatelli, Francesco, Covic, AdrianOptimal composition of the dialysate, with emphasis on its influence on blood pressure, Oxford Journals - The Nephrology Dialysis Transplantation, volume 19, Issue 4 pp 785-796.


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The Comparison Between Different Herbs and Spices Containing Phenolic Compounds on Inhibition of Amylase: A Study for Type 2 Diabetes

Shaalini Desai
Aatmika Deshpande

Type 2 diabetes is a common condition associated with amylase, an enzyme that breaks down starch into glucose. Diabetic patients experience a lack of glucose intake and have to counteract this with insulin shots. This experiment helps to find a more natural remedy: herbs. Phenol is a chemical compound known to inhibit amylase and is found in rosemary, cilantro, and ginger. Comparing these three will help determine the most successful amylase inhibitor. The independent variable was the type of herb, and the dependent variable was the absorbance of the solution. The control was distilled water. Essential herb oil, starch, iodine, and amylase were put into a test tube for the reaction process. Then the absorbance value, or how much starch the enzyme was able to convert to glucose, was measured with a colorimeter. Rosemary, with a mean absorbance of 1.2, was most successful, followed by cilantro, with a mean absorbance of 0.54. The control and ginger had similar mean absorbance, 0.46 and 0.48, respectively. An ANOVA test resulted in a p-value less than 0.01. Therefore, the null hypothesis that the type of herb/spice would have no difference on the absorbency was rejected and the alternative hypothesis is accepted. The experimental hypothesis that rosemary would have the largest absorbance value was supported; rosemary was the more effective inhibitor. More research could be done, like testing the effects of these herbs on other enzymes found in the pancreas, or with other substrates of amylase.


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The Effect of Magnesium, Aluminum and Calcium Based Anti-acids in Protein Digestion

Megana Kasavaraju

The purpose of this experiment is to determine whether antacids impede the digestion of proteins in the stomach, since this can lead to many diseases including mental disorders, cancer, autoimmune diseases, and protein, mineral, and vitamin deficiencies. To determine this, stomach acid was stimulated by using HCl and pepsin. Then protein was added. For the first group, magnesium hydroxide based antacids was added, for the second group, aluminum hydroxide based antacids was added, and for the third group, calcium carbonate based antacids was added. Then the amount of time taken to dissolve the protein was determined. The change in pH caused by the antacids was also recorded. The t-test showed that dissolving the protein took a significantly longer time with the addition of antacids. The t-test also showed that there was a significant change in pH with the addition of antacids. A key result determined was that the aluminum hydroxide based antacid created the smallest change in pH and also took the least amount of time to dissolve the protein. Also, the calcium carbonate based antacids created the greatest change in pH and also took the greatest amount of time to dissolve the protein. This shows that there is a direct correlation between the change in pH and the time taken to dissolve the protein. The hypothesis was accepted. Since protein digestion is impeded with the use of antacids, people should resolve their health conditions instead of temporarily relieving their symptoms with antacids.


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Detecting GMO’s in DNA of Alfalfa Hay Using Electrophoresis and PCR

Alexa Knoell

GMO’s (Genetically Modified Organisms) in horse feed is very controversial and the labeling of GMO’s is inconsistent and not required in America. This study potentially impacts the nutrition of equines. The purpose of this experiment was to see if GMO’s would be detected in Non-GMO and unspecified alfalfa hay samples. In this experiment, the independent variable was the alfalfa brands, which were Triple Crown, Semica, and Dumor. The dependent variable was whether or not GMO’s were present. The main steps in this experiment were isolating the DNA, amplifying the DNA via PCR, and running electrophoresis to view the data. The results indicated after running the electrophoresis that the Dumor brand of alfalfa, which was unspecified, contained GMO’S. The Triple Crown, a brand claimed as GMO free, and the Semica brand, unspecified for GMO’s, were found Non-GMO. DNA samples will be submitted for sequencing to GENEWIZ then uploaded to the BLAST database for further study and comparison. Further research to be explored with this experiment could include testing percentages of alfalfa fields infected with GMO’s via pollen-mediated transgene flow and what effect GMO alfalfa has on equine performance and health.


Meyer, R. (1999). Development and application of DNA analytical methods for the detection of GMOs in food


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Assessing Traditional Chinese Medicine in Treating Colon Cancer

Jasmine Lu

Although chemotherapy remains one of the most prevalent means of tackling cancer, it comes with numerous drawbacks which include the harrowing side effects suffered by patients. Some regimens are prone to inducing necrosis, a harmful form of cell death that results in the collateral damage of surrounding cells, over apoptosis, the more methodical and controlled form of cell death. This study seeks to measure a synergistic effect amongst curcumin, hydroxycamptothecin, and triptolide—three compounds drawn from traditional Chinese medicine—in killing SW480 colon cancer cells through apoptosis. By observing such synergy, these natural compounds will demonstrate their potential as agents in a low-dose, low-toxicity combination treatment. Trials for each individual chemical were run, showcasing the efficacy of each compounds in killing an SW480 human colon cancer cell line, which was indicated by assaying for the phosphatase levels present in the cell suspension following treatment. From here, combination trials will be performed in hopes of exhibiting a synergistic anticancer effect amongst the three chemicals. Caspase assays will also be performed to determine the degree to which the cell death was driven by the process of apoptosis by measuring the activity of the proteins that lie nearly directly upstream of the apoptotic event. Capitalizing on the potential of traditional Chinese medicine may mitigate the harrowing conditions cancer patients shoulder during chemotherapy, improving their quality of life of cancer patients.


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The Use of Burdock Root as a Natural Treatment to Alcoholic Liver Damage

Abigail Watts

In 2009, alcohol-related liver disease was the primary cause of nearly 1 in 3 liver transplants in the United States, according to the National Institute for Alcohol Abuse and Alcoholism. Natural methods are currently being explored to counteract damage done to the liver from ethanol exposure. The burdock plant (Arctium lappa) is said to have a detoxifying effect on the body. When damaged liver is exposed to burdock, the burdock should promote liver function, which will be measured by the amount of catalase enzymes present in a 10mL sample. The goal of this research is to test burdock root as both a preventative measure against and as a treatment for livers damaged by alcohol. The method used to test liver function before and after exposure to ethanol, with and without burdock, includes a catalase test that collects the volume of oxygen produced by the solutions in each trial. Preliminary research suggests that the burdock does not improve liver function when compared to liver exposed to ethanol with no treatment; however, it was found that the burdock breaks down the ethanol, eliminating the need for the liver to function at the high rate needed to break down ethanol when acting alone.


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<td>Gladish, Erin Puller, Gabrielle</td>
<td>The Effect of Nanoparticles in Sunscreen on C. elegans Growth Inhibition</td>
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<td>420X11</td>
<td>Whitehill, Jennah</td>
<td>Investigating Antidepressants as a Potential Treatment for Concussions</td>
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The Effect of Nicotine and Cigarette Smoke Condensate on the Neural Development of Zebrafish

Rohni Awasthi
Rachael Cheung

Studies have shown that many women smoke while pregnant. The various chemicals in cigarettes are transferred to the infant through the placenta and correlate with difficulties to the infant such as low birth weight, sudden infant death syndrome, and long term cognitive effects. The purpose of this experiment was to test the effects of nicotine and smoke condensate on neural crest development using zebrafish as a model organism.

Zebrafish eggs were exposed to levels of nicotine at 0, 50, 100, 500, and 1000 ng/mL from 0 to 5 days post fertilization (dpf) or cigarette smoke condensate (CSC) at levels of 0, 0.04, and 0.12 percent CSC. For both groups on 5 dpf measurements were taken of total body and head size, which correlate with neural crest development.

Body measurements were significantly shorter in fish exposed to nicotine compared to the control (Kruskal-Wallis, P greater than 0.05). Head measurements were significantly shorter in fish exposed to nicotine compared to the control (ANOVA, P less than 0.0001). The Tukey-Kramer Comparison test showed significant difference between the control and all experimental groups (P less than 0.05).

Body and head measurements were significantly shorter in fish exposed to CSC compared to the control (Kruskal-Wallis, P less than 0.0001). The Dunn’s Comparison test showed significant difference between all experimental groups with P less than 0.001 except for the group S-0 vs. S-1 where body measurements had a P greater than 0.05.

The results show that both nicotine and CSC had an effect on the body and craniofacial development of the zebrafish indicating that nicotine has an effect on neural crest development.


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The Analysis of a Mutant Version of APOC3 for Future Uses in Treatment

Arul Vignesh Balla

For thousands of years heart disease has been plaguing the human race. However, with this experiment, the lowering of heart disease risk may soon be a possibility. The R19X mutated version of protein from APOC3 was isolated, which will help lower the risk of developing heart disease. This experiment produced an APOC3 with the R19X mutation in the protein outside of the human body in Escherichia coli BL21 (DE3) cells in order to analyze its functions and to find the conditions that give the highest protein yield. In order to counteract the non-polarity of APOC3, a Nus-A tag was added to the end of the protein which allowed for easier purification. After extensive testing of various temperature ranges, the conditions were identified that resulted in a high protein yield of the mutated APOC3 protein. Future paths of study for APOC3 include the conducting of lipid binding competition assays to assess the percentage of lipids that are not bound by the mutant protein in comparison to the original APOC3.


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The Effect of Natural Anticoagulants on Limulus polyphemus’ Coagulation System

Mannat Chawla
Richa Malhotra

Many adults have been recommended to intake anticoagulants to reduce the risk of medical complications; however, there also comes the risk of excessive bleeding. More research was conducted to find a natural way to obtain the same effects of anticoagulants. If natural anticoagulants are administered to the Limulus polyphemus, then there will be an effect on the coagulation system.

Natural anticoagulants were administered through worms for each group of Limulus polyphemus to eat over a period of time. Afterwards, the Limulus polyphemus were pricked with a needle and bled onto a piece of filter paper, and on each paper, the diameter of the blood was measured to see which group bled more. Furthermore, there is a control group which received no anticoagulants.

There was a slight change of the amount of blood that was bled from the Limulus polyphemus’. The group that received the natural anticoagulants bled more with one needle prick than the control group.

Both researchers contributed towards the experiment; however, help was received from a qualified scientist to support the Limulus polyphemus’ habitat and to give scientific advice. The objective was met since there were differing effects with the group that received the natural anticoagulants and the control group.

In conclusion, with there being a larger diameter of blood on the filter paper, natural anticoagulants do have an effect on the coagulation system. This experiment may be continued by experimenting with different anticoagulants, or by obtaining a larger sample of Limulus polyphemus’ to receive more accurate results.


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The Effect of Antioxidants on Oxidative Stress Levels in C. elegans as it relates to Alzheimer’s Disease

Madelyn Clark
Marykate Crawford

Alzheimer’s Disease (AD) is a neurodegenerative disease that is characterized by a slow, irreversible loss of memory, usually beginning after age 60. Oxidative stress, which has also been linked to aging, is an imbalance between the production of free radicals and the ability of the body to counteract or detoxify their harmful effects through neutralization by antioxidants. If oxidative stress is maintained at a balanced level, the aging process will slow, causing AD development to delay. A direct correlation between foods containing antioxidants and a decreased risk for AD has yet to be found. In this experiment, C. elegans were plated on different petri dishes containing E. coli and the following antioxidant rich foods: spinach, strawberries, glutathione, green tea, and cloves, with a control group containing only E. coli as a food source. After one week of maturation and exposure to antioxidants, the six groups of C. elegans were placed in a solution of hydrogen peroxide and M9 buffer to induce oxidative stress. The C. elegans were then monitored every half hour for the rest of their life span. While testing is ongoing, the strawberry fed group has demonstrated the longest life span in relation to the other antioxidant exposed groups. In Phase 2, C. elegans with a predisposition for AD will be obtained and fed the antioxidant that promoted the longest survival rate in Phase 1. The responsiveness of the C. elegans, and thus the development of AD, will then be tested by a touch test.


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**Preventing Staphylococcus epidermidis and Pseudomonas fluorescens Infection and Growth Using Fungal Volatile Organic Compounds with and without Lactobacillus acidophilus**

Kyle Enriquez

Every year, severe burns kill approximately 265,000 people due to opportunistic infection from normal flora, such as Staphylococcus epidermidis. This research aims to prevent these deaths through the use of natural volatile organic compounds (VOCs) produced by many types of fungi. VOCs (isobutyric acid, benzaldehyde, butanol, and cineole) were added to S.epidermidis cultures. After 48 hours at 37C, absorbance was measured to determine bacterial growth. Isobutyric acid and benzaldehyde significantly inhibited growth of S. epidermidis (Kruskal-Wallis p value less than 0.0001, Dunn's Comparison p value less than 0.001). Aiming to not inhibit the growth of Lactobacillus acidophilus, a potential additive, the VOCs were applied to L. acidophilus, and after 48 hours of incubation, the remaining biofilm was stained with crystal violet and absorbance was measured. Benzaldehyde, butanol, and isobutyric acid did not inhibit this growth (Dunn’s p value greater than 0.05). The effect of VOCs in combination with L. acidophilus on S.epidermidis was then determined. S. epidermidis was grown with VOCs and L. acidophilus with appropriate controls; absorbance was measured. This test showed that isobutyric acid with L. acidophilus significantly inhibited S.epidermidis growth over the VOC alone (Kruskal-Wallis p value less than 0.0001, Mann Whitney p value less than 0.01). VOCs were then applied to Pseudomonas fluorescens to determine if inhibition could also be seen in gram negative bacteria. Cineole, benzaldehyde, and butanol all significantly inhibited P. fluorescens growth (Kruskal-Wallis p value less than 0.0001, Dunn’s p value less than 0.01). The next step of this research is to apply these VOCs with and without L. acidophilus to cell cultures in hopes of taking this treatment from bench to bedside in order to evaluate the effects of possible treatments on living tissues.


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The Impact of Nanoparticle Toxicity on Danio rerio Neural Development and Effectiveness of Antioxidants in Reversing the Gross Effects on Fetal Development

Sydney Fox
Vikram Seshadri

Despite their vast use in products around the world, nanoparticles are believed to cause detrimental abnormalities for developing human fetuses, such as cardiovascular damage or improper muscle formation. Nanoparticles have been found to aggregate on cell membranes and produce free radicals byproducts. Free radicals, highly reactive byproducts of nanoparticle metabolism, can cause oxidative stress that can promote abnormal fetal development. Antioxidants detoxify free radicals and may reduce the effects of nanoparticle toxicity.

Danio rerio were used as a model organism. To determine the SiNP concentration, Eggs were exposed to silica nanoparticles (SiNPs) at 0, 2.50, or 5 mg/mL from 0 to 96 hours post fertilization (hpf). To test the efficacy of antioxidants in reducing the toxic effects of free radicals from nanoparticle metabolism, eggs were exposed to 0 or 5 mg/mL SiNPs and 0 or 250 µM ascorbic acid. Survival rates were measured for 96 hpf. At 96 hpf, head, body, and eye lengths were measured.

Danio rerio exposed to 5 mg/mL of SiNP were significantly longer in body length compared to the control group with no exposure (Kruskal-Wallis, P less than 0.01; Dunn’s Multiple Comparison Test, P greater than 0.05), showing nanoparticles damage fetal development. Furthermore, Danio rerio that were exposed to 5 mg/mL SiNP in conjunction with ascorbic acid were not significantly longer in body length compared to the control group (Dunn’s, P greater than 0.05), showing ascorbic acid ameliorated the toxic effects of nanoparticles on fetal development. Results for eye and head measurements are pending. For an extension of this project, eggs could be exposed to quantum dots to study how nanoparticles spread throughout a developing fetus.


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The Effect of Aspartame on the Neurological Condition of C. elegans

Emily Fuhrmann
Luis Salinas

The purpose of this experiment was to investigate the allegations of negative effects as a result of the excessive consumption of aspartame. This was done by conducting research on C. elegans and analyzing any neurological deterioration that took place when they were injected with a predetermined concentration of the substance. The C. elegans were subject to a very specific dosage of aspartame every day until they perished. The independent variable for this experiment was the amount of aspartame that was administered. The dependent variable was the development of Alzheimer’s, or lack thereof, in the form of a visible loss of motor functions. The control was a group of C. elegans that were not given any aspartame. The results of this experiment were minimal noticeable losses of motor functions in all groups, except the group that were injected with the highest concentration of aspartame, being 0.2g diluted in 150ml of distilled water, which exhibited almost a total loss. These results provide a conclusion which supports the plausible correlation between an excessive intake of aspartame and neurological deterioration taking place. Further research on the subject could investigate other types of artificial sweeteners and their possible negative effects on neurological function.


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The Correlation between a human gut bacteria, Bacillus subtilis, and commonly ingested chemicals: in synergy with a probiotic.

Devin Geier

The gut flora is a very important part of the body however it is often overlooked. The gut flora helps with the immune system but when unbalanced can also contribute to obesity, heart disease, and mental disorders. This project’s goal was to see how Bacillus subtilis would react when it was exposed to caffeine and acetaminophen. A probiotic was added to the broth for half of the test tubes. Growth was determined by a spectrometer measuring transmittance. The independent variable was the probiotic. The dependent variable was the transmittance value and the control group was the bacteria with no probiotic. The mean value for transmittance in the caffeine group with no probiotic was 7.42% and the probiotic group was 7.70%. The p-value is 0.010867. The mean transmittance value for acetaminophen when there was a probiotic was 7.76% and when there was no probiotic was 7.85%. The p-value was 0.614626. The alternative hypothesis is the probiotic would help the bacteria grow and protect it from the caffeine and acetaminophen. The probiotic did help the bacteria against the caffeine because of the p-value being low. However when exposed to acetaminophen the probiotic didn’t have an effect because the p-value is high. Interestingly, the probiotic did not protect against the two chemicals equally. Considering that the gut flora is an important part of the body further research should be conducted to evaluate how other bacteria react to other chemicals or explore how a probiotic could possibly help address obesity, heart disease, or mental disorders.


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The Effect of Nanoparticles in Sunscreen on C. elegans Growth Inhibition

Erin Gladish
Gabrielle Puller

The purpose of experimentation is to determine whether or not common nanoparticles in sunscreens, such as titanium dioxide and zinc oxide, affect the growth and movement of C. elegans. In this experiment, 11 petri dishes of C. elegans were cultured, chunked and separated into different groups; half were submerged in freshwater and half saltwater. There were three trials of each sunscreen concentration at .25g, .5g, and .75g respectively. Each dish was observed under a stereoscope and the present state of the C. elegans at that time, including growth and movement, was recorded. The C. elegans placed in saltwater dishes did not grow as large or move as much, and had shortened lifespans. The average movement for C. elegans in saltwater was 0.9 on the scale of 1-5; the average for freshwater was a 2.79. Our hypothesis – if tested at an equal concentration, then a salt water solution will deliver harsher effects directly to the C. elegans, therefore further inhibiting growth – was proven true. However, the focus of experimentation was on the concentration of nanoparticles within the solution, rather than the salinity of the water. In addition, the concentration of sunscreen in the solution yielded no apparent affect on growth or longevity of life; but the controls were healthier than those in any sunscreen solution. A major source of error was the water spilled and inexact measurements in chunking. How may this type of research further affect other biota; would the affect be more or less pronounced?


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The Development of a Transdermal Drug Delivery System Derived from Bombyx mori

Emma Gnatowski

During the late 1970s, researchers introduced the very first over-the-counter transdermal drug patch, Transderm-Scop, which contained a drug used to treat motion sickness. Since then, no more than thirty different transdermal drug patches have been approved by the Food and Drug Administration. Transdermal drug delivery patches, in their most advanced form, fail to execute drug release technology that exceeds 10 days of use and are not dissolvable.

The purpose of this research was to create a transdermal drug patch that effectively delivered a drug, with a high molecular weight, for at least fourteen days. The combination of tensile strength and biocompatibility of silk fibroin from Bombyx mori and the elasticity and lipid surface of a glycerin-infused gelatin film were created to work as multilayered transdermal drug patches. Degummed silk fibroin was dissolved in 54% wt. lithium bromide solution and dialyzed. This silk fibroin was combined with glycerin-infused gelatin to create multilayered patches. These soluble patches were infused with three different concentrations of the antibiotic Rocephin and were tested on Staphylococcus epidermidis. Zones of inhibition were noted, indicating bacterial death. Patches dissolved quickly and lasted approximately seven days. Dissolution of the patch was complete most likely due to incubation temperature. Further research will entail increasing the longevity of the patch by manipulating Rocephin concentrations.


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The Efficacy of Using Lemna minor as a Mammalian Model Replacement in Medical Research

Simran Kala

Every year, millions of animals are mistreated in order to further medical testing. Lemna minor, or duckweed, is an aquatic plant that does not possess an immune system. However, it displays the capability to produce an ‘immune response’ to harmful bacteria. The purpose of this research was to determine whether duckweed could serve as a suitable substitute to the use of vertebrates in medical research. Lemna minor was infected with Streptococcus salivarius and Escherichia coli K-12 for five days. Chlorophyll production was used as an indication of overall cell health. Chlorophyll concentration was determined using a Gen5 plate reader. It was determined using statistical analysis that there was no significant difference in chlorophyll production in the Escherichia coli K-12; however, there was a significant production in Streptococcus salivarius. Hence, Streptococcus salivarius mounted a response to the infection. In fact, the chlorophyll production response was greater in duckweed subjected to higher levels of bacteria. Therefore, the idea that duckweed may serve as a suitable replacement for animal subjects in medical testing is supported.


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The Effect of Vitamin D and Omega 3 Fatty Acids on Serotonin Levels in the Model Organism Drosophila melanogaster

Sahithi Kalvakota
Sameera Sunkara

Depression is an illness that impacts many lives across the world; most people experience it at one point in their lifetime. Prior research suggests that it is caused by serotonin deficiency. Two chemicals known to influence serotonin level are vitamin D and omega-3 fatty acids. Vitamin D is a hormone that plays a vital role in activating tryptophan-hydroxylase 2, a protein involved in serotonin synthesis, while omega-3 fatty acids located on the plasma membrane of neurons help regulate the release and reception of serotonin.

The effect of different levels of vitamin D and omega-3 fatty acids on the serotonin level was measured in this experiment using the model organism Drosophila melanogaster. As a pre-experiment, tryptophan, a chemical known to increase serotonin level, was mixed into the Drosophila’s medium, and inter-fly distance was measured. The resulting measurements were used as a behavioral assay for serotonin level.

To determine the effect of vitamin D and omega-3 fatty acids on the serotonin level, Drosophila were given 0, 0.089, or 0.178 mg vitamin D per 5 mL of medium or 0, 1.875 mg, or 3.75 mg omega-3 fatty acids per 5 mL of medium. The behavioral assay was used to compare serotonin levels between the experimental groups and control. Data is pending.

A source of potential error was the use of inter-fly distance and aggression as measurement of serotonin level. Though proximity between flies provided an indication of their inclination to move towards each other, there was no physical interaction between them, therefore aggression may not be an accurate conclusion. Further research could use a chemical assay in order to achieve more accurate results.


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Creating a Cost-Effective Polymerase Chain Reaction Machine

Varun Kulkarni

Polymerase Chain Reaction, or PCR, is a process used in biology that allows for scientists to efficiently make copies of a given strand of DNA. The process is used in laboratories to have multiple copies of DNA so that multiple tests or analyses can be run on the given type of DNA. PCR functions with a protocol of temperatures that a sample goes through. Temperature set points allow for the machine to open, replicate, and anneal DNA multiple times to provide a full solution of DNA. This investigation aims to reduce the building cost of such a machine while trying to maintain a level of efficiency and accuracy. A normal machine would usually cost three thousand to ten thousand dollars, and the goal of this study is to bring the costs to less than one hundred dollars while risking the least inaccuracy possible. Various materials were explored during the project and their durability, responsiveness, and overall place in the machine were evaluated constantly as was the design of the machine. In addition, coding methods and algorithms were explored such as PID (Proportional Integral Derivative) statistics. Bearing in mind the possible implementations of the project, it is possible that the machine can be further aesthetically improved by making applications for mobile devices to interface with the machine. Further goals include mobile device implementation as well as manufacturing other PCR related products (such as an electrophoresis box) in a similar cheap but effective manner.


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The Effect of Curcumin on Memory Retention of C. elegans

Pamela Michel
Jeyda Turker

The purpose of this experiment is to show that Curcumin can be a treatment used to battle diseases like Alzheimer’s. Its anti-oxidative and anti-inflammatory properties are what improve memory. To prove this, C. Elegans were tested. First, the memory span of C. Elegans was taken without the Curcumin compound added. Then, Curcumin was added to a test group of 16 C. Elegans. After 2 days, their memory span was tested again and compared to 16 control group C. Elegans without Curcumin. The independent variable was the Curcumin given, and the dependent variable was the recorded change of memory span. The results with 16 trials were positive. The biggest improvement was seen in C. Elegan number two, injected with 0.5 uL of Curcumin. Its memory improved by 8.83 seconds. The other C. Elegans injected with 0.5 uL of Curcumin did not have memory improvements. The average memory span of C. Elegans for the test groups before injection was 16.03 seconds, and afterwards was 14.81 seconds. There was an average improvement in memory of 1.22 seconds. The experimental hypothesis: If Curcumin is injected into C. Elegans, then the memory span of C. Elegans will increase, was supported based on our results. Curcumin influenced the memory span of C. Elegans. A major source of error was incubating the culture in an environment with uncontrolled temperatures, which affected the growth of the microorganisms. Future research could explore the different amounts of Curcumin injected and their effects to determine successful amounts of Curcumin.


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The Effect of Edelfosine on the Growth of C. elegans

Nikhat Nusrat
Brennah Rohner

As the cancer epidemic continues to grow and affect the lives of an increasing amount of people, a less harmful substitute for chemotherapy treatments is necessary. Edelfosine is an anti-cancer drug that induces apoptosis in white blood cells. What makes this particular drug unique is its ability to identify and target the cells that are harmful to the body, such as tumor cells. Unable to use human subjects for testing, scientists are forced to test this drug on C. elegans. The genome of Caenorhabditis elegans is very similar to that of humans, making the results of such experiments reasonably accurate. Since an excessive amount of Edelfosine administered can be fatal, this particular experiment was meant to determine the point of fatality. The C. elegans were allowed two weeks to develop. Afterwards, different groups were administered various amounts of the Edelfosine. Radiation was administered to each group for ten minutes twice a week until the life span of the C. elegans came to an end. The life span of the C. elegans was meant to increase if they were administered Edelfosine levels ranging from 5µm to 10µm. As the experiment progressed, it became apparent that they were not receiving enough radiation because they continued to develop at a normal rate. Because of the limited amount of radiation administered, the higher levels survived longer than the lower levels of Edelfosine.


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The Mechanism of Anti-Cancer Drug Docetaxyl

Vladyslava Rybka
Aleksey Veselov

Docetaxyl is common drug used in chemotherapy where it controls and limits the cell division. This drug disrupts the mitotic progression and inhibits the micro-tubules (cell's apparatus for dividing and replicating itself) resulting in a cell death. Hypothesis is that Docetaxyl inhibits autophagic pathway. The question of the research - how is autophagy inhibited? The project gave data of how docetaxyl inhibits a cell's death. The HeLa cells were treated with different Docetaxyl concentrations (10nM, 30nM, 100nM). After a two day period the number of alive cells was counted using the cell counting assay. The standard deviation was taken of the Docetaxyl concentrations to understand the optimal concentration. Western blotting was used to detect LC3B-II (mediator of autophagy), which would determine if Docetaxyl promotes autophagy. Then siRNA knockdown with cell counting assay was used to see if that attenuates Docetaxel induced death. The Docetaxyl drug killed cells and that is thought because it inhibits autophagy. Autophagy can lead to the death of the cell or to the survival of it. Data showed that Beclin-1 expression is down regulated by Docetaxyl. This project helps in discovering the more information about how docetaxel affects certain proteins in cells and the efficiency of the drugs concentrations.


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Investigating The Effect of the Drosophila melanogaster Sleep Mutation Fumin on Susceptibility to Oral Infection by Serratia marcescens

Alyssa Sandefer

Although the full biological purpose of sleep is currently unknown, previous research has shown a positive correlation between duration of sleep following the introduction of a disease and rate of recovery. The Drosophila melanogaster mutant fumin is hyperactive and sleeps for fewer than four hours per day, yet is apparently able to subsist on its shortened sleep without major ramifications. Thus, the question arises as to whether sleep duration or sleep sufficiency is truly what is needed to fight off infection. To test the hypothesis, wild-type w1118 and fumin mutant Drosophila will be orally exposed to equal concentrations of pathogenic Serratia marcescens Db11 bacteria. Post-infection death rates in the presence and absence of Db11 will be measured and compared for w1118 and fumin flies. These results will determine whether there is a significant impact of the mutation on Drosophila susceptibility to disease. Data collection is underway. Because fumin may be viewed as an organism that has “adapted” to sleeping for a shorter-than-average period of time, the results of this experiment are expected to shed light on the relationship between chronic sleep loss and immune function, as well as to indicate whether or not other negative consequences of sleep deprivation and restriction ought to be reexamined using fumin as a model organism for chronic short-sleeping individuals.


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Blue Light Interference of Melatonin: a Sleep Disruptor

Grace Solini

Melatonin is the hormone responsible for controlling circadian rhythms and sleep cycles. Melatonin levels affect the body's state of arousal and attention and are regulated by photonic suppression. Different wavelengths affect the brain differently and sources of blue light, such as mobile devices, are most effective in melatonin suppression. While melatonin suppression is necessary for regulation of circadian rhythms, overstimulating the eyes and brain with blue light, especially before periods of sleep, can suppress melatonin enough to actually disrupt sleep cycles. The purpose of this research was to investigate whether decreased use of blue light technology before periods of sleep could improve sleep health and allow greater periods of deep sleep.

Subjects monitored regular sleep patterns for two weeks using the “Sleep Time” application, and then continued to monitor these patterns for an additional two weeks while also limiting technology use one hour before sleep. Data was analyzed by comparing the ratio of time spent in deep sleep to total time spent asleep for the first two weeks with the same ratio of the second two weeks. It was determined that limiting technology use an hour before periods of sleep did not have a significant effect on how much time each subject spent in deep sleep each night. Additional research would increase the subject numbers and extend the time periods for control and test groups in order to ensure greater validity of the results. Such research would provide insight into whether technology truly has an immense effect on sleep patterns.


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The Relationship Between Strike Angle when Running and a History of Medial Tibial Stress Syndrome

Ellison Taylor
Hana Warner

Medial-tibial stress syndrome, musculoskeletal inflammations more commonly known as shin splints, is a common running injury. However, there are many conflicting opinions on what causes shin splints to develop. This experiment examines how runners’ strike angle relates to a history of shin splints, particularly when examining the force ratio between the runners’ force while running compared to their weight. Runners were surveyed to learn their shin splint history and their standing weight was recorded by having them stand on a pressure plate. Runners were then recorded as they ran over the plate, which allowed the strike angle to be obtained and the runners’ force of running to be calculated.

It was found that runners with a shin splint history experienced a mean strike angle of 4.5º and a mean force ratio of 21.494 while runners who had shin splint history experienced a mean strike angle of 3.277º and a mean force ratio of 35.213. The experimental hypothesis that the strike angle, and thus the resultant force ratio, had a relationship to a history of shin splints was rejected. A t test was conducted which yielded a p value of 0.8620, examining strike angle and a p value of 0.9305 when examining the force ratio, therefore failing to reject the null hypothesis. Further research could include examining the relationship between the runners’ impulse to their shin splint history or the relationship between runners’ shin splint history and their energy ratio when comparing running to walking.


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Investigating Antidepressants as a Potential Treatment for Concussions

Jennah Whitehill

Concussions occur as a result of blunt force trauma to the head that causes the brain to knock against the skull. As many as an estimated 3.8 million occur each year. This traumatic brain injury causes neuron death and concussions have been shown to cause early onset of neurodegenerative diseases. Antidepressants have been shown to stimulate neurogenesis in adults; St. John’s Wort is an herbal antidepressant which was shown to be more effective than a placebo. Drosophila melanogaster have been used in previous research to model concussions. If Drosophila melanogaster is given a concussion then St. John’s Wort will extend its lifespan compared to concussed untreated Drosophila due to stimulation of neurogenesis. The independent variable is the treatment regimen given to the flies and the dependent variable is the lifespan of the flies. There are four experimental groups: untreated Drosophila without a concussion, untreated concussed Drosophila, proactively and retroactively treated concussed Drosophila, and retroactively treated Drosophila. Drosophila are given concussions that simulates a bus crash. Treatment will consist of a St John’s Wort and Ethanol solution at the maximal tolerated concentration determined by a toxicity assay. Some data for untreated concussed flies has been collected and it shows a noticeable shortening of Drosophila lifespan. Data collection for the experimental groups is underway. If St. John’s Wort is able to extend the lifespan of Drosophila melanogaster after receiving a concussion, it could potentially provide a simple, effective treatment for concussions.


Schatz, P., Moser, R., Covassin, T., Karpf, R.. Early Indicators of Enduring Symptoms in High School Athletes with Multiple Previous Concussions. Neurosurgery, 68(6), 1562-1567. Doi: 10.1227/NEU.0b013e31820e382e

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Decreasing Fungal Pathogenicity by Breaking Disulfide Bridges in the Yap-1 Protein

Ngozi Akingbesote

Fungal infections in humans range in severity from mild to life-threatening. Some fungal infections exist as mild skin rashes, but others can be deadly, such as fungal pneumonia. Therefore, it is important to employ treatments as soon as possible so as to decrease severity. The purpose of this research was to determine whether fungal pathogenicity could be reduced by chemically manipulating the Yap-1 protein in an effort to break disulfide bridges that form due to oxidative stress. The conformational shape change by the Yap-1 protein allows a fungus to adapt to hostile environments therefore retaining its pathogenicity.

Caenorhabditis elegans were cultured in five sets and four sets were infected with Saccharomyces cerevisiae. Three cultures of C.elegans were each treated by exposing them to different chemical environments: one containing hydrogen peroxide, the second containing thioredoxin and the third containing both hydrogen peroxide and thioredoxin. The last two cultures served as controls in which the environment was not manipulated. It was determined that fungal pathogenicity can be reduced by using treatment via a reducing agent such as thioredoxin because disulfide bridges formed during oxidative stress can be broken in a reduced environment. Further research should entail exploring how reducing agents such as thioredoxin affect the human immune system when fighting fungal infection and explore how this method can be applied to pharmaceutical medicine to further advance the creation of antifungal drugs.


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Creating A Model Organism For The Study of Tay Sach's Disease Using RNA interference of the Hex-1 Gene in C. elegans Using Custom RNA Oligo Soaking

Meghan Bradshaw
Connor Pritchard

Tay-Sachs disease is a rare autosomal recessive disease that destroys neurons in the brain and spinal cord through a defect in the HEXA gene. The mutation of the HEXA gene causes a deficiency of the enzyme, Beta-hexosaminidase A. This deficiency results in the cell’s failure to dispose of GM2 gangliosides and becomes deadly to the cell. In this research, RNA interference (RNAi) was used to create a model organism to study the disease. C. elegans are nematodes that possess the hex-1 gene, which corresponds to the human HEXA gene. In order to mimic Tay-Sach’s disease, the hex-1 gene was inhibited by a custom RNA oligo of 21 bp synthesized with 2’ O’Methyl groups and a Phosphorothioate backbone that resist endonuclease reaction. Another RNAi duplex was synthesized as a control group containing the same modifications and testing of RNAi in the interference of the hex-1 gene in C. elegans commenced. If RNAi is used to knock down the hex-1 gene in C. elegans, then the specimen will model the same protein deficiency of Tay-Sachs disease, thereby creating a model organism to study the human HEXA gene. Observations of the effects of RNAi soaking on L-1 C. elegans include sporadic, limited locomotion and stunted growth, possibly due to a buildup of GM2 Ganglioside. Control worms, soaked in autoclaved water, displayed much more rapid growth and fluid movement. Further steps are currently being taken to analyze each worm group’s protein composition and examine the effectiveness and extent of the hex-1 gene knockdown.


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Apoptotic Response of Cancer Cells to Resveratrol, Nitidine Chloride, and Cepharanthine

Saahithi Budharaju

Current cancer treatment practices rely heavily on chemotherapy which has various side effects and can weaken the immune system. Novel drugs derived from natural products are less toxic, and have demonstrated greater success in decreasing cancer cell proliferation in in-vitro studies. Several compounds have been identified as agents inhibiting cancer cell growth through the initiation of apoptosis. These compounds have displayed anti-tumor and anti-inflammatory properties via activation of the caspase pathway, including resveratrol, nitidine chloride, and cepharanthine. Each compound is derived from natural botanicals such as berries and herbs, and have been used individually as treatment for acute and chronic diseases with minimal side effects. Resveratrol, nitidine chloride, and cepharanthine are all agents that have been found to inhibit cancer though the caspase cascade individually, but not in combination. This study will identify the cytotoxic effect of each compound and the synergistic effect of the combination in a dose dependent manner. 4T1 mouse breast cancer cells have been cultured, and several phosphatase assays have been performed on treated and untreated cells to determine cell viability. Data collection is currently in progress.


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The Effect of Nicotine on Learning Ability in Drosophila Larvae

Caitleen Copeland

Nicotine increases the neurotransmitters Dopamine and Acetylcholine, neurotransmitters involved with memory and learning. In previous studies, it has been found to increase long-term Hippocampal learning (Justin W. Kenney, 2008). This information can be used to fight diseases such as Alzheimer’s and Parkinson’s which decrease cognitive function partly due to the loss of Dopamine and Acetylcholine. Nicotine could replenish some of these lost neurotransmitters and decrease cognitive deterioration in patients (A.Lynn Wilson, 1995). To test nicotine’s effect on learning ability, Drosophila larvae were administered nicotine for ten minutes before being trained to associate Amyl-Acetate (AM) with a fructose reward against Octanol (OCT) with no reward. The larvae were given a choice between AM and OCT at the end of training and a preference score was calculated. A different set of larvae were then reciprocally trained to associate OCT with fructose and AM with no reward. The same test and calculation was administered (Cold Spring Harb Protoc, 2013). A Learning Index (LI) score was calculated using the two preference scores to determine the extent to which the larvae learned. Several nicotine trials were done and compared against the control group given no nicotine. The highest three LI scores for each group were used to show a distribution and to calculate a p value through a t-test. The p value supports the alternative hypothesis that pure .01% Nicotine solution improves learning in Drosophila larvae with a p value of .04. This study was limited by the number of trials that could be done due to lack of time and materials. More trials are needed to further support the alternative hypothesis.


Cold Spring Harb Protoc; 2013; doi:10.1101/pdb.prot071639


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CD-47 is a protein that is expressed on the membrane of some cells, and over expressed in cancer cells by almost 1000x, it sends a signal that implies it is a healthy cell; by sending this signal, macrophages are deterred. This protein is how cancer cells bypass the immune system. Previous research has determined that metal nanoparticles of approximately 13 nanometers induce cellular death in cells by depleting them of glutathione. A conjugate was made consisting of a CD-47 antibody and gold nanoparticles. The conjugate serves as a more targeted and efficient means to induce cancer cell death, assuming that it attaches more frequently to cancer cells than healthy cells. Cancer cell membranes expresses CD-47, so the antibodies will attach themselves to the cell while the gold nanoparticles will deplete it of its glutathione thus killing it. The conjugate will also be tested on non-cancerous cells to see if the treatment is targeted mostly towards cancerous cells. Data shows that the conjugate kills approximately 70% of cancer cells versus only 20% of noncancerous cells.


Do Labels Tell You the Truth About Genetically Modified Products?

Natalie Hernandez
Natalia Patino Rosales

Whether through the use of genetic engineering or selective breeding, the study of GMOs has advanced over the years. Along with the interest in GMOs in food consumption, comes the issue of GMO labeling. This experiment tests whether GMO and non-GMO labeling is correct in four corn flakes products. The independent variable was the four brands of corn flakes tested for GMOs. The dependent variable was whether or not the samples tested positive for GMOs. The DNA of the four samples was isolated and then duplicated using PCR. Horizontal gel electrophoresis was used to detect GMOs in the samples by looking at the lanes on the gel plate under a transilluminator, which was stained with InstaStain Ethidium Bromide for 15 minutes.

Two trials were conducted. The data results were the same for each trial. In each trial results revealed that two of the samples tested positive for GMOs, the Giant brand and Kellog’s frosted flakes. These were not advertised as GMO free. Nature’s Path (labeled Non-GMO) tested negative. Kix tested negative with no specified GMO labeling. The four tests in each trial, which revealed truthful labeling, did not support the hypothesis.

This research could be strengthened by testing more samples. We are in the process of submitting DNA samples to GENEWIZ for DNA sequencing and will then upload this information to the BLAST database for further analysis.


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The Effects of Non-Ionizing Radiation on Escherichia coli Bacteria

Shubhi Maheshwari
Iman Sayed

Radiation has been known to cause mutations in biological material, which ultimately leads to the development of cancer in cellular matter. The purpose of this research is to see if exposure to various types of radiation can inhibit the growth of bacteria, preventing food-born illnesses, applying the concepts of mutations and cancer. The experiment was conducted to see if radiation on different levels of ionization would have an effect on the growth or inhibition of Escherichia coli bacteria. The experimental process is designed to test the exposure of microwave and ultraviolet radiation on E. coli bacteria in proportional intensity levels. The thermal factor was controlled by the application of heat kept constant through each experimental group. Throughout the experiment, the different radiations were kept constant through proportional intensity and units of lux. The data showed that the microwave and ultraviolet light radiations hindered the growth of bacteria and was greater than the average growth in comparison to the control group. The ultraviolet light, measured in frequency, inhibited the growth of the E.coli significantly whereas the microwave radiation was less conclusive. Testing the effect of the high-energy radiation on actual food items such as raw meat and unpasteurized milk to find real-world applications can further extend this research.


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Comparing the Effects of Enzymatic and Supplemental Antioxidants on Telomere Length

Shannon Morrical

Telomeres are caps on the end of chromosomes that determine the lifespan of a cell line. Every time a cell replicates, its telomeres shorten slightly, until they shorten enough to cause the cell to be susceptible to disease and premature death. Telomere shortening can be decelerated by the repair of oxidative stress damage by antioxidants.

Antioxidants are categorized into supplemental antioxidants, taken by mouth, and enzymatic antioxidants produced by the body. The purpose of this research was to determine which type of antioxidant, or a combination of the types, is most effective in repairing oxidative stress damage on telomeres. This result will be used to determine the best supplements to decrease risk of age related disease for those with a history of illness. The experiment was tested in Tetrahymena protozoa, model organisms for telomere function. The Tetrahymena were incubated with ascorbic acid, a supplemental antioxidant known to decrease telomere shortening, and green tea extract and green coffee bean extract, two supplements known to induce the production of enzymatic antioxidants, after being exposed to hydrogen peroxide to induce oxidative stress. DNA was then extracted and used to measure telomere length. Experimental data is still being collected.

Cawthon, R. M. (2002). Telomere measurement by quantitative PCR. Nucleic acids research, 30(10), e47-e47.


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FOXO Transcription Factor: A Novel Therapeutic for Cardiometabolic Disease

Marissa Sumathipala

Risk of cardiovascular disease, the world's leading cause of death, is greatly increased by metabolic syndrome, a combination of hyperlipidemia, hypertension, and type-2-diabetes. A rapidly growing global health challenge across all age groups, cardiometabolic disease affects 25 percent of adults globally, 10 percent of children and 50 percent of adults over 60 in the US.

Current therapeutics for metabolic syndrome treats each cardiometabolic disease component separately; blocking liver cholesterol formation in hyperlipidemia or reducing liver glucose production in type-2-diabetes. To more effectively treat cardiometabolic diseases, therapeutics that target the many underlying metabolic pathways common to the disease components are needed. This research investigates the viability and efficacy of FOXO proteins, which control gene transcription of cellular pathways, including glucose and lipid metabolism, as a novel therapeutic target.

FOXO transcription factor was expressed in adipose tissue by crossing two Drosophila transgenic lines, GAL4-driver line with RU486-Gene-switch and dFOXO line, and raised on high-fat (HF) or high-sugar (HS) diets. Abdomens were surgically dissected without damaging beating hearts, and videos were analyzed. Cardiac tissue was fixed, fluorescence-stained, and actin-myofibrils imaged.

FOXO-expressing flies on HS/HF diet exhibited therapeutic benefits of reduced cardiac dysfunction: 24 percent-reduced heart rates, 52 percent-reduced arrhythmia, 52 percent-higher fractional shortening (t-test,p-less-than 0.05). When expressed prior to HS/HF-diet placement, FOXO exhibited protective roles: 45 percent-reduced heart rates, 72 percent-reduced arrhythmia, 72 percent-higher fractional shortening (t-test,p-less-than 0.05).

Structurally, FOXO prevented cardiac hypertrophy.

Successfully reducing mortalities and treating diet-induced cardiac dysfunction-severe arrhythmias, tachycardia, and cardiovascular hypertrophy and rigidity, FOXO shows promise as a novel drug target with both therapeutic and protective roles. Future work will investigate drug delivery methods of FOXO.


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The Use of the Alternated Soaking Process to Create a Chitin-Goethite Nanocomposite Optimized in Tensile Strength

Soham Dessai

The teeth of limpets, consisting of goethite nanofiber within a softer protein phase, have been proven to be the strongest natural occurring material. A bio-inspired nanocomposite was modeled after these teeth in an attempt to achieve a similar tensile strength. The novel alternate soaking process was used to make a chitingoethite nanocomposite that would be optimized in tensile strength. A chitin film was first developed using an existing method and was alternately soaked in goethite and chitin using a crane made from an inexpensive robotics kit. The number of soakings was changed after each trial, starting at 20 soakings and incrementally increasing by 20 soakings. The nano-composites were then tested for tensile strength. They were later viewed under a Scanning Electron Microscope for better understanding and a visual representation of the composite. Data is forthcoming and is expected to be collected by March 2016.


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The Effect and Cost Efficiency of Natural and Chemical Pesticides and Repellants on Formicides (Ants)

Amanda Hakins

This project consisted of a number of experiments to determine which substances provided the most reliable and cost effective solutions for repelling ants. Chemical pesticides, household products, and natural repellants were used in these tests. A simple test setup was constructed allowing the number of ants crossing a boundary treated with each substance to be counted over a predetermined period of time. The fewer ants crossing the boundary, the more effective the substance was at repelling them. If the cost of the substance was low and repelled ants efficiently, then the product would be considered cost efficient. Even though the natural repellants (hot sauce, lemon juice, etc.) were the best at repelling, they were not cost-efficient to use. The chemical pesticides were very cheap to use but did not actually repel the ants in a timely manner, but they did kill the ants off over time. The most cost-efficient product to use was a laundry softener followed by dishwashing liquid. These detergents demonstrated the fewest number of ant crossings, along with a low cost.


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Synthesis of Multifunctional Nanoparticles to Induce Hydrophobicity and Antibacterial Properties on the Surface of Packaging Materials

Seoyoung Kang
Yeojin Min

The objective is to synthesize silica-coated silver multifunctional nanoparticles that can exhibit hydrophobic and antibacterial properties. Using different silane chains to change the degree of hydrophobicity, the goal is to find the most hydrophobic and antibacterial nanoparticle solution. These multifunctional nanoparticles have potential applications in the packaging industry. Materials can be coated with a nanoparticle solution, resulting in a hydrophobic and antibacterial surface that can repel water and kill bacteria. This combination can help to protect the contents inside of packages. To make these nanoparticles, a silver colloid was synthesized then coated with different silane chains: TEOS, VTES, OTES, and ITES. The hydrophobicity was measured by coating a glass slide with a nanoparticles solution, pipetting a drop of water on it, and measuring the contact angle. The antibacterial property was observed by growing E. coli in the presence of nanoparticle-dipped filter paper pieces and measuring the disk of diffusion. Nanoparticles were successfully synthesized. Out of all the coatings, VTES induced the highest contact angle. Data has yet to be collected for the antibacterial test. As of now, no conclusions can be made. Ultimately, the multifunctional nanoparticles will be hydrophobic as well as retain antibacterial properties to increase the consumer satisfaction in the delivery of packages.


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Effect of Bicarbonate Salts on the Growth Rate of P. itallicum

Connor Kirk

The Purpose of this experiment was to determine whether or not the addition of NaHCO₃, KHCO₃, or NH₄HCO₃ would have an effect on the growth rate of P. itallicum. P. itallicum is a fungus that can grow on citrus plants and result in killing most of the crop. To experiment, four dishes of each condition were prepared, Control, NaHCO₃, KHCO₃, NH₄HCO₃. Each bicarbonate salt was prepared by adding 1ml of the solution into the respectively labeled dishes. Once the bicarbonate salt was added, the dishes were inoculated with a reusable loop that was sterilized after each usage on each dish. Once all dishes were inoculated, they were placed in an incubator set to 250°C to allow to grow, and number of colonies recorded on each day. The data could only be calculated for the first two days since on the third day all dishes exhibited lawn growth. However, based on the calculated data there is enough evidence to support that KHCO₃ did have an effect on the initial growth rate of P. itallicum.

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Identification of Optimal pH for Luminol Chemiluminescence

Megan Salvatore
Nathan Vigil

The purpose of this experiment is to determine which pH is most effective at optimizing luminol’s chemiluminescence reaction (C8H7N3O2). This glowing blue light emitted by the reaction of luminol and hydroxide ions forming dianions has caused luminol to become a practical tool for investigating crime scenes. Forensic investigators can utilize this information to increase both the effectiveness and validity of luminol in investigations and court cases. A variation in pH is an easily encountered problem when creating luminol and perfection becomes necessary in order to produce the longest duration of usable luminol. This optimal pH was determined through repeated experimentation on the duration in which luminol lasted according to various pH levels. This research is significant because it can help to improve the performance of luminol when used at a crime scene. Through knowing the pH that optimizes the reaction of luminol, forensic investigators can utilize this information to increase the effectiveness of luminol in investigations.


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The Effect on Photocatalytic Efficiency of Changing the Ratio of ZnO and SnO2 in Nanoparticles for the Purification of Water

Surbhi Singh

This research explores methods to increase the photocatalytic efficiency of zinc oxide-doped tin dioxide nanoparticles. Water splitting using a photocatalyst has gained attention for its potential applications to break down environmental pollutants in water. The reaction begins when photons are released from a light source to excite the electrons in the photocatalyst. A major disadvantage of using tin dioxide as a photocatalyst is that it only absorbs ultraviolet rays due to its large band gap (3.6?eV). The photocatalytic process slows down when electrons fall from the conduction band back to the valence band. This recombination is inevitable in photocatalytic systems but can be reduced by adding co-catalysts. Rather than starting the chemical reaction, these co-catalysts accelerate and increase the duration of the reaction. Previous research has shown that zinc oxide doping increases photocatalytic activity of SnO2 nanoparticles by increased charge separation. It is hypothesized that if the molarity of ZnO in ZnO doped SnO2 nanoparticle photocatalysts is increased, the efficiency of the nanoparticles in methylene blue degradation will increase due to the increased charge separation and extended wavelength absorption spectrum. Data of the first batch of ZnO-SnO2 nanoparticles doped at the lowest ZnO concentration has been collected. It has shown a significant increase in photocatalytic efficiency from the control. More nanoparticles will be synthesized with increased amounts of Zinc Oxide to compare photocatalytic efficiency of increased dopants under both ultraviolet and visible light. Two statistical tests, ANOVA and Kruskal-Wallis, will be run to determine significance.


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## Computational Biology & Bioinformatics (700)

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Using Bioinformatics to Find Out which Individuals are Resistant to the SARS Virus

Akhil Gajjala

This project aims to figure out which variant of the human ACE2 protein could make people resistant to the virus. By aligning the wild type protein to similar mutant variants, we can figure out which protein variant of ACE2 can make people resistant to the SARS coronavirus. The research was done by gathering data from the GeneCards database, we can get up-to-date information of possible mutations of the ACE2 protein. By considering the missense and frameshift mutations of the ACE2 protein, we can see whether or not the mutations are considered in the following pdb entries in the protein data bank. The wild type (normal protein) is the protein that is going to be used as the control, for now, we know that it binds to the actual viral protein. I found several mutants that don't align very well to the wild type protein and this could be an indication that we can predict the population of individual that can be resistant to the SARS coronavirus.

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The Effect of Nephila clavipes Spider Silk on the Regeneration of the Distributed Nervous System in a Heterometrus longimanus

Manav Parekh

The regeneration of the peripheral nervous system of many different species has been made possible by the use of spider silk, such as from the Nephila clavipes spider. Scientists have yet to test the silk on the central nervous system or a similar system. To test the effect of the N. clavipes silk on a similar system, a methodology was created based on previous experiments. N. clavipes spider silk was collected. The effectiveness of the silk was tested on a Heterometrus longimanus, an Asian Forest Scorpion. The scorpion’s tail was severed and a wrapping was laced with the silk (independent variable) and covered the tail. In order to see if the tail had full nerve regeneration, action potentials were measured (dependent variable) before the severance, which was the control, after severance and at the end of the experiment. In the data collected, the final mean action potential was 90 mV which closely compared to the 92mV measured before the tail was severed. After running a t-test, the data was statistically significant, and the spider silk was found to have helped regenerate the nerves in the tail of the scorpion. The null hypothesis was not supported. This experiment demonstrates that spider silk can help regenerate the nerves in a system close to a human’s nervous system as stated in the alternative hypothesis. Further research could explore the effectiveness of the spider silk on the central nervous system of a human and other vertebrate animals.


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Testing the Relationship Between Intermittent UVa Irradiation and Cancer Development in D. melanogaster

Joseph Stefano

UVa light makes up 95% of UV sunlight and 100% of light from tanning beds. This intense level of UVa light means humans are exposed to UVa light very frequently. This experiment measures the effect of UVa exposure time on tumor development in D. melanogaster in order to quantitatively model the relationship between UVa irradiation and cancer. Four Drosophila strains that develop cancer due to the downregulation of tumor suppressor genes were exposed to UVa light for intervals between zero and forty-eight hours during their larval stage for the experimental trials. After UVa exposure the Drosophila larvae were allowed to develop into adults and their eyes and wings were scored for tumors as a function of UVa exposure time. A positive linear relationship was found between UVa exposure time and tumor number. The chi-squared test was run that compared the measured data and predicted values from the line of best fit which resulted in a high p-value, failing to allow rejection of the null hypothesis that the line fits the data well. This model predicts that when the time is less than 13 hours, no flies will develop tumors. Further experiments are underway with intermittent UVa exposure in order to test this prediction and to better model the exposure humans have to UVa light. This will further our understanding of the destructive nature of UVa light and provide a quantitative model for using it to elicit tumor growth.


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Analysis of the Phylogenetic Basis of the Evolution of Plancitoxin I in Acanthaster planci (Crown-of-Thorns Starfish)

Jessica Wimberly

Recent growth of bioinformatics has led to the determination of phylogeny of many organisms. However, research conducted examining specific features, such as venom, is uncommon. The crown-of-thorns starfish, Acanthaster planci, is one of the only known venomous starfish. It produces a protein, plancitoxin I, that contributes to the degree of toxicity of the venom. The purpose of this research was to identify organisms with similar venom to determine the evolution of the venom.

Nucleotide and protein sequences of plancitoxin I were identified via GenBank. Using nucleotide and protein sequences, other organisms with venom similar to plancitoxin I were identified and BLAST searches were conducted to compare resulting organisms. Matches with E-values of less than 0.0 and identification percentages of greater than 40% were used to create a distance tree using the BLAST Tree View Widget. Eight sequences from different organisms, such as the California sea hare (Aplysia californica) were found to be significant in the phylogeny of the venom and were used to create the tree. Plancitoxin I in A. planci was found to be the third most primitive among the sequences used to create the phylogenetic tree.

Further research would entail the identification of additional sequences similar to plancitoxin I in A. planci. Research would also include the analysis of amino acid similarities between resulting significant sequences to find structural and functional similarities. These similarities would allow for the creation of an antivenin based on existing knowledge of the venom found in similar organisms.


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Physical Profile of the Beaverdam Reservoir

Rahym Ahmad
Camron Barghi

This experiment serves as a personal study to learn more about the water quality of the Beaverdam Reservoir. This study is beneficial to the public and the reservoir staff because it provides useful information about the quality of the water before and after winter weather. The Beaverdam Reservoir is a major water source and provides space for activities and recreation throughout the year. The information gathered from this study can provide an explanation as to why certain species of fish thrive in the reservoir and why it is beneficial as a water source and public area. It will also show the impact of snowfall on the water quality of the reservoir. Two samples were taken from ten different locations once in early winter and once after snow. Each sample was tested in the lab for the following: temperature, pH, conductivity, dissolved oxygen, total hardness, alkalinity, nitrites/nitrates, chlorine, and turbidity. Among these tests, the most prominent are pH and dissolved oxygen as they have a profound effect on human activity and fish that occupy the aquatic environment. When comparing results from the tests during early winter and after snowfall, there are both differences and similarities. Based on the results, it can be concluded that the water quality is suitable for human use and aquatic life both before and after snowfall, even while noting the changes. It can also be determined that snowfall has the capability to alter the reservoir water quality in certain aspects but keep it stable in others.


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The Correlation between Environmental Factors in a Wetland and Nitrous Oxide Emissions

Sarah Alvarez

Greenhouse gases are a huge for our environment and Nitrous Oxide (N2O) is one of the gases predicted to increase 5% from 2005 to 2020. Forty percent of N2O emissions are from humans, mainly agriculturally linked. A huge contributor is from the runoff from livestock that flows downstream into the wetlands. The goal of this study was to test if constructed wetland environments could be altered to lower the amount of N2O released in the atmosphere. To perform this experiment, nine different wetland environments were constructed. The independent variables are the amount of water in the wetland and the temperature. The dependent variable is the percentage of N2O in the air. The data was analyzed using multiple anova tests resulting in being able to reject the null. The environment of the wetland does matter, it’s not due to random chance. They hypothesis was that the model with the lowest temperature and water percentage would release the least amount of N2O but the data supports that the model with the lowest temperature and the highest amount of water released the least amount of N2O. This demonstrates that there is a correlation in low temperature. Further research can be expanded from the project in different environments in order to discover other ways to decrease the production of N2O gas. If constructed wetlands become more widely used for pollution filtration, it is necessary to control the amount of nitrous oxide that is being released from the nitrate filtering wetlands.


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The Effect of Ibuprofen on Algae Growth

Skyla Bailey
Stefan Carter

Pharmaceutical drugs in the water has been a cause of concern for many years. Ibuprofen being one of the most identified in the waters. Ibuprofen can cause “inhibition or stimulation of growth in aquatic plant and algae species” (Boxall 2004). This could drastically change environments. How much effect will the ibuprofen have on the growth of algae? There were four samples in the experiment, with increasing amounts in each jar and the control with no ibuprofen. The independent variable is the amount of ibuprofen and the dependent variable is the growth of the algae. It was found that there was not a significant difference between the algae growth between each jar except for jar four and jar one because jar one was the control and jar four had the highest amount of ibuprofen in it. This is because the amount of ibuprofen has to be very high to actually effect the growth of algae. There needs to be more research on the topic and more trials done to make the data more accurate.


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Poison Down the Drain: The Effect of Triclosan Concentration on Daphnia magna heart rate

Colleen Bush
Anwen Knudson

Triclosan [5-chloro-2-(2, 4-dichlorophenoxy) phenol; TCS] is a widely used antibacterial agent, found within a wide range of consumer products, that when washed down the drain, eventually ends up in waterways. In order to determine specifically how triclosan affects the environment, this experiment analyzed how freshwater Daphnia magna reacted to varying levels of concentration (µg/L). The independent variable in this experiment was the concentration (µg/L) of triclosan while the dependent variable was the resulting heart rate (bpm) of the species. The control group was exposed to no triclosan. Daphnia magna are microscopic freshwater crustaceans. The experimental groups were exposed to triclosan for approximately five minutes and then they were placed under a microscope for observation. The means for each concentration of triclosan were 296.04 bpm for 0 µg/L, 230.31 bpm for 10 µg/L, 188.83 bpm for 20 µg/L, and 199.16 bpm for 30 µg/L. An ANOVA test was utilized for statistical significance. The alternative hypothesis that the higher concentration of triclosan would result in a lower heart rate was accepted because the average heart rate declined as the concentration was increased. These findings indicate that triclosan does in fact have a large impact on cardiovascular and muscle systems within Daphnia magna. The independent variable directly influenced the dependent variable. Further research could be done by studying how disrupting Daphnia magna could also affect other organisms in their food chain.


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Effect of microplastics on Brine Shrimp

Mohammad Chohan
Deepak Goel

This project investigates the effect ingestion of micro plastics and their environmental present on the base of the marine food chain, brine shrimp. The project determines the effect of dissolution of micro plastics on phenol concentrations in the salt water. When micro plastics from household products such as body washes dissolve in water, phenol is released into the water. Phenol is a hydrophobic compound released from micro plastics that is highly toxic and caustic. It was hypothesized that the ingestion of micro plastics and toxicity of phenol will negatively affect the behavior and body processes of brine shrimp. Identical populations of brine shrimp were grown and then split into groups. One groups of shrimp comprised the control group in a salt solution only, and the other groups had various micro plastics concentrations added to their solution. The control group population remained constant for the 96 hours before population begin to decease. However, when the micro plastics solution, varying in concentration respectively, were added to the experimental groups, the population decease in less than 72 hours proportional to concentration. It was noted that even in smaller concentration the population decreased after 72 hours significantly in comparison to the control and in larger concentration population after 91 hours deceased to less than 5% of the control. It can be concluded that micro plastics and exposure to toxic phenol have a damaging effect on the life span of brine shrimp. Further investigations of these groups to verify finding and increase data will continue.


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Iron fertilization is the process in which Iron compounds are released into aquatic environments purposely to induce algal blooms that can capture carbon dioxide. However, these algal blooms could cause anoxic zones as the algae die and are decomposed by bacteria that could deplete the local oxygen levels. The purpose of this experiment was to determine whether or not Iron Fertilization significantly reduced dissolved oxygen levels in an aquatic environment. Algae was grown in eight, one liter bottles for about a week. After a week Iron (II) Sulfate Heptahydrate was added to the bottles in various concentrations of 0 ppm to .1 ppm. Analysis of the collected data showed found an r value of -0.02898 and an r squared value of 0.0008400. The p value was 0.9457. Thus in conclusion there was no significant association between the concentration of Iron (II) Sulfate Heptahydrate and the concentration of dissolved oxygen. The implications of this are that Iron fertilization is a process that could be used to counter climate change and also produce little impact on aquatic dissolved oxygen levels.


The Effect of Turf Crumb Rubber on the Health of Freshwater Ecosystems

Austin Edwards

Turf fields are supposed to be a better alternative to regular grass fields because they reuse tires and do not need to be watered, maintained and cut. The tires are reused and are turned into crumb rubber comprising the black pellets which are seen on almost every turf field in the country. Recent studies have shown that this rubber contains carcinogens and other harmful chemicals which can be released into water via run-off or by heat as fields become very hot in summer. No studies have yet to definitively show the impact of crumb rubber and the chemicals on humans or surrounding ecosystems. The purpose of this research was to determine the effect of crumb rubber on surrounding freshwater ecosystems by collecting crumb rubber from a turf field and testing its effects on a freshwater bacterium, Aquaspirillum serpens. Aquaspirillum exposed to crumb rubber exhibited little to no growth. In addition, the same lack of growth was shown by the common ecosystem bacterium E. coli. Further research would entail exploring the effects on organisms at the bottom of the aquatic food chain to determine whether exposure to crumb rubber causes adverse effects. Exploration of the effects of exposure to this common component of turf field is warranted.


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The Effect of Cornmeal Based Solution on the Growth of Didymosphenia geminate

Nihant Ganta
Nicholas Westerlund

This experiment intended to discover whether or not natural algae killers could be used to combat an invasive species, Didymosphenia geminate, which was unavailable, so the diatom Synedra mazamaensis, was used due to the nearly identical composition of the cell walls. The Synedra mazamaensis was exposed to different cornmeal mixtures or no mixture at all. The diatoms were given three days to grow before testing began. After 24 hours in the mixtures, four drops were harvested from each for observations. The t value was 3.9686. The null hypothesis is rejected because the calculated t value was greater than the table t value. The experimental hypothesis, “If a cornmeal solution is applied to a diatom, the growth of the diatom will decrease,” is supported. The algae clusters exposed to the mixture were fewer in number, and smaller in size than the control. Further research could be done in order to find out which specific compounds in the mixture caused the algae population to shrink.


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The Effect of Golf Course Fungicide Runoff on the Macroinvertebrate Community Structure of Streams in Loudoun County, Virginia

Tara Maire Gravallese

Golf course fungicide runoff is affecting the macroinvertebrate community structure of streams adjacent to golf courses. Most golf courses use pesticides to keep the grounds free of weeds and to keep the fairways as green as possible (aesthetic appeal). In this research the local specific bodies of water that are being affected are Sugarland Run Stream, Old Sugarland Run Stream, and Algonkian Stream. All of these respective streams are part of the Potomac River Watershed. Consequently, this fungicide pollution is contributing to overall pollution levels in the Potomac River and its environmental community. The health of living organisms in the river is being compromised, as is the food chain. Macroinvertebrates are organisms that are crucial for the management and completion of the food chain and help identify pollutants (such as fungicide). In order to assess this issue, three Loudoun County streams (names mentioned above) were tested and six trials were performed on each stream. For each trial three samples were taken. Two out of the three local streams were directly adjacent to golf courses. The third stream was upstream one mile from the course. Data analysis supported the idea that areas with high usage of pesticides affect the nearby streams and bodies of water.


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The Effect of Different Filters on the Amount of Microbeads that Enter Waterways

Aditi Jadhav
Rida Jamal

Microbeads, small spheres of plastic used as an exfoliator in personal care products have been called out for disturbing humans and wildlife; which, without knowing have consumed plastic that has absorbed toxins. The purpose of this experiment is to find an eco-friendly method of filtering (Independent Variable) the beads to prevent them from entering waterways (Dependent Variable) and destroying ecosystems, the control group was treated without any filters. This problem was tested by diluting 15 grams of face wash (100 beads) in 237ml of water and pouring the mixture over three types of filters (burlap fabric, mesh, and burlap fabric coated with basil seeds), that were placed on a bowl. The microbeads that were caught by the filters were counted and trials were repeated 10 times. Though basil seeds worked better, catching 99.9 beads on average, the results were fairly close, with mesh catching 96.2 beads and burlap fabric catching 96.3 beads. The data was put into an ANOVA test, which yielded a p-value of p is less than 0.01, meaning the null hypothesis has been rejected and that the different filtering methods used, truly affected the number of microbeads caught. The experimental hypothesis which stated that the basil seed filter will catch more microbeads was supported by the data. Further research can explore the effect of different fabrics, crops and seed filters on microbeads entering waterways.


Chen, C. "Is your face wash damaging the oceans?." Christian Science Monitor. 2015, September 20: n/a


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Analyzing Histogram Values of Pictures to Quantify Air Pollution

Alexander Klimavicz

Air pollution in the form of particulate matter (PM) is a health hazard. Monitoring air pollution is a challenge due to cost and limitations of technology, therefore an app based on data similar to this would be more efficient. This study was to generate and analyze data from a pictorial histogram of a picture of a simulated PM condition by lighting controlled fires against a set background. Pictures were taken before and after the fire was lit. The before picture data is considered the baseline for all other analysis. Initial testing used a whiteboard as the background. Secondary testing was shot with a woodland background to represent a real world situation. Histograms of pictures were then analyzed in Adobe Photoshop. Histogram channels analyzed included RGB, Red, Green, Blue, and luminosity. In the initial test each channel decreased in value once PM was introduced. Each channel decreased an average of 3 on a scale of 0-256. The largest decrease was blue with 4.31. Exact values vary between experiments as a result of conditions at the time of testing. A paired T-test was used and generated significant P-values for each channel tested. P-value average was .000024. Results indicate that particulate matter significantly alters each channel in a histogram. The data could be used as PM sources for designing a smartphone app to measure PM in real time monitoring.

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Combating the Algae Blooms in the Chesapeake Bay Using the Photosynthesis Inhibiting Toxin of the Bacteria Vibrio shilonii

Malvika Kuncham
Jeevna Prakash

Algae blooms are harmful events that interrupt the ecosystem of the water body by disrupting its oxygen levels. A process called eutrophication encourages the growth of algae; runoff from fertilizers that contain nitrogen and phosphorous cause resident algae populations to explode. Normal algae populations are a part of the ecosystem, however the decomposition process of massive algae populations deprives other organisms of oxygen. This project serves to provide a possible solution to algae blooms in the Chesapeake Bay. Vibrio shilonii is a seawater bacteria found in the Mediterranean that produces a toxin called toxin-P that inhibits photosynthesis in coral by lysing the symbiotic zooxanthellae. This research attempts to take the photosynthesis inhibiting property of Vibrio shilonii and use it as a combatant for algae blooms. A synthetic version of the toxin was tested in various concentrations with algae under regular bloom conditions brought upon by exposing them to increased levels of phosphorus. Dissolved oxygen levels and cell counts were taken to see the mortality levels of the algae. Data collection continues, but preliminary tests show no increased mortality in the presence of the toxin, and actually show an increase in oxygen production over a 48 hour period compared to the control. Further research is being conducted to investigate these results.


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Fertilizer Runoff At 1757 Golf Club

John Magnelia

Fertilizer runoff is harmful for the environment and can cause harm to wildlife and pollute surrounding bodies of water. My research question while testing the stream and ponds near 1757 Golf Club asked whether or not the methods that the golf club had put into place were working and if they were, how effective were they. To address my question, I tested a pond located near the stream that flows through the golf course, upstream from the golf course and downstream from the golf course. I collected the field measurements and conducted five nitrogen tests and five phosphate tests at each testing location. The variable was the testing location. After conducting all the field measurements and analyzing the data, I found that while the phosphate and nitrate levels varied from day to day, the phosphate and nitrate levels were very similar across the three testing locations. Repeating the test during warmer months when the course is fertilized more often might change the results as during colder, winter months the course is fertilized less regularly. One limitation to the study would be the large amount of snow that could have skewed the results.


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The Effect of Sea Surface Temperatures on Aggression in Sharks

Rachel Melton

A shark attack is considered to be any interaction between sharks and humans with the threat of injury or death toward the human. Shark attacks have drastically increased yearly and hit a record high in 2015 of fifty-one attacks. While research exists as to why sharks attack, there has been little if any research on the effect of sea surface temperature on shark aggression. This research endeavored to determine whether increasing sea surface temperatures played a role in increased shark aggression.

Data regarding sea surface temperature was collected from the National Data Buoy Center and data regarding shark attacks was taken from the Global Shark Attack File and mapped using ArcMap. This data was analyzed to determine whether a correlation existed between the sea surface temperatures and the number of shark attacks over a span of nine years. The data supports the hypothesis that a correlation existed between increasing sea surface temperatures and an increase in the aggression of sharks.

Further research would entail determining what, if any, role temperature plays in triggering biochemical pathways involved in aggression in sharks. In addition, whether fish migration is affected by changing sea surface temperatures should be explored since fish are a staple of shark diets. This would provide a greater understanding of shark behavior and the role environmental conditions may play.


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Potomac River Tunnel Project

Adam Mueller

The Potomac River is one of the most polluted rivers in the U.S. The pollution is affecting surrounding areas of the river. Being from here I use the Potomac River in many ways, therefore I want the river to be as clean as possible and the tunnel will help a lot with that. The river pollution is killing off some fish and other animals that use the river. If the pollution persists it will permanently harm the river and everything in it. Collected water samples from the Potomac for a couple weeks to see if there is a change in the quality. I was testing pH level, Dissolved Oxygen, Nitrates and turbidity. Haven’t seen big changes in the quality but the Potomac is one of the biggest in the US so it will take time to see results, but I think it will help a lot with the environment and the marine life in the river.

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<tr>
<td>Dissolved Oxygen    14.1 mpl    14.0 mpl    14.1 mpl    14.2 mpl    14.0 mpl</td>
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<tr>
<td>Turbidity    3 ft    4 ft    3.8 ft    3.5 ft    2 ft</td>
</tr>
<tr>
<td>PH level    7.7    7.5    7.9    7.2    7.5</td>
</tr>
<tr>
<td>Nitrates   1.62ppm   1.64ppm     1.58ppm    1.60ppm    1.62ppm</td>
</tr>
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</table>

The Potomac River tunnel I believe will improve the water quality slowly but surely. You won’t see improvements right away but overtime it will become worth it.

https://www.dcwater.com/workzones/projects/potomac_river_tunnel/default.cfm

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East Coast Beach Erosion

Matthew Oswald

The problem of erosion along coastal beaches should be explored and studied because many beaches are affected by erosion. If the beaches become eroded and run down it can affect multiple things such as: wildlife, their ecosystem, and human life that's lives off the coast. The problem being explored is determining how much these beaches are being eroded yearly.

The approach towards this research was very simple. How much does the effect of currents have on beach erosion and to whether a certain coasts erodes faster than others? Choose 18 beaches from the along the east coast and evaluate the erosion caused on those beaches. The northern beaches were compared to the southern beaches and the units were measured in the amount of sand being eroded in meters per year. Maine’s beaches erode at a rate of .305 meters per year, Delaware’s beaches erode at a rate of 1.23 meters per year, Virginia’s beaches erode at 2.225 meters per year, North Carolina’s beaches erode at 3.51 meters per year, Florida’s beaches eroded at a rate of 0.701 meters per year and New Jersey’s beaches erode at a rate of .609.

The data collected on currents was unclear and had no correlation to the erosion response from the beaches. Storms did cause a large amount of erosion on the beaches in a short period of time in the beach “hot spots.” The data collected shows that the beaches along the middle portion of the east coast eroded at a higher rate than the beaches at the north and south ends. There definitely needs to be constant research on erosion because it is occurring all the time and beaches are always changing.

http://www.beachapedia.org/State_of_the_Beach/State_Reports/VA/Beach_Erosion
http://www.beachapedia.org/State_of_the_Beach/State_Reports/NC/Beach_Erosion
http://beachapedia.org/State_of_the_Beach/State_Reports/NJ/Beach_Erosion

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Recent construction displayed detrimental effects on ecological habitats. In response to environmental changes, water quality; including the physical, chemical, and biological characteristics were assessed. Upon assessment, local rivers can be classified if the body is suitable for healthy aquatic organisms and ecological interactions. PCR analysis of water samples from various rivers aided with determining their overall health. DNA electrophoresis was ran on PCR products, used to compare the relative quality of healthy and unhealthy rivers. Bands of similar lengths on the healthy rivers indicated DNA sequences that characterize greater quality, and vice-versa. Research was coupled with the collection of organisms in rivers alongside various chemical assessments on phosphate, nitrate, alkalinity, pH, and dissolved oxygen levels. Phosphate, nitrate, and dissolved oxygen concentrations for the Broad Run River was 4.3, 0.85 mg/L, and 8.7 ppm respectively. Comparisons with EPA standards indicate a respective deviation of 240, 32, and 41.86% for phosphate, nitrate, and dissolved oxygen concentration. The deviated concentrations indicate that the Broad Run River quality is ecologically unacceptable.


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Utilizing Dinoflagellate Bioluminescence to Facilitate Continuous Algal Photosynthesis at Various Temperatures

Elena Puccio

Water chemistry in aquatic ecosystems has been altered dramatically in recent years. As a result of global warming, dissolved oxygen levels in bodies of water have decreased, increasing the size and amount of anoxic zones. Increased levels of carbon dioxide in oceans have caused a decrease in the concentration of calcium carbonate in seawater, hindering the processes that corals go through in order to calcify. Increased levels of photosynthesis, through carbon fixation and oxygen production, would help both increase the levels of calcium carbonate in water and increase the percent saturation of dissolved oxygen in the water. This research will determine the temperature at which overall oxygenation capacity of the marine algae Nannochloropsis can be maximized while exposing the algae to blue light bioluminescence from the dinoflagellate Pyrocystis fusiformis. Each trial at each of the four temperatures consisted of three controls (algae, dinoflagellates, saltwater) and one experimental flask (algae and dinoflagellates). Change in dissolved oxygen over five hours was determined to quantify photosynthesis. Between measurements, the flasks were placed in a water bath to control their temperature, which was covered with cloth to simulate a night period for the dinoflagellates and placed on stir plates with stirring rods to stimulate the dinoflagellates and cause them to produce light. Data collection is ongoing, but preliminary results show that increase in temperature was not able to increase photosynthetic capacity enough to surpass the decrease in oxygen solubility, and that augmented photosynthesis was unable to surpass respiration.


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The Effects of Human Pollutants on the Growth Rate of Sargassum Seaweed

Marie Rubright

Sargassum seaweed has been aggressively overtaking the beautiful Caribbean beaches. Researchers believe that Sargassum’s growth has increased a great extent within the last 5 years. This is thought to be because of the increase in human made pollution. With increasing sargassum the tourist industry is decreasing because of the ugly and potent smell. In order to test this compare the weight of Sargassum before and after testing it with Nitrogen based fertilizer, petroleum based oil, and ammonium nitrate and urea (used as a human waste concentration). Add different amounts of each substance to the sargassum and observe how much the sargassum grows after sitting for 72 hours. Each substance should be added to the sargassum in a separate petri dish to observe which man-made pollutant causes the sargassum to grow faster. Record the information gathered and calculate the weight difference. With live sargassum the weight difference will vary between 0.0369g to 0.284g. The average weight difference when adding 5mL of each substance to separate petri dishes is 0.2754g. The weight difference is not drastic but it does change until the sargassum begins to rot then the weight will drop to a difference. The first set of data was inconclusive. The sargassum seaweed began to die before the experiment was completed. This caused the data to have the opposite effect than the hypothesis. It did not grow; the weight of the seaweed decreased.


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Northern Snakehead Correlation of Water Quality

William Tattersall

Being an avid fisherman of the Potomac River (below Great Falls) has me concerned with the recent outbreak of Northern Snakehead. Being native to Asia, and born with no natural predators is causing a huge threat to the US waterway ecosystems. The problem with these fish being in our waters is that they are exterminating the primary source of food, Banded Killifish. The Snakehead has an abnormally fast rate of reproduction and with its ferocious appetite they are on the track of making this baitfish extinct. To prevent furthermore spread as well as provide long-term adaptive management is the goal. Does water quality in the Creeks, have any relation with the numbers of Northern Snakehead that have been recorded? I took water samples from each creek to test the quality. I was trying to see if the quality differed; therefore, the fish prefers a certain quality of water. Hoping to find a consistent reading determining that the fish thrives in these waters for a certain reason. When the results came back, it turns out that all the readings were the same. Each creek had the same levels on the tests. [Temperature 47.7’, PH level 8.1, Nitrate level 1.63, D.O. level 15.] With these results it is hard to say if there is any correlation between the quality and the populations in these creeks. With weather and inconsistent readings being a factor, my results are inconclusive until further testing and research.

www.dgif.virginia.gov dnr2.maryland.gov/fisheries/Pages/snakehead.aspx

nas.er.usgs.gov/taxgroup/fish/northernsnakeheaddistribution.aspx

www.invasivespeciesinfo.gov

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The Effects of Ocean Acidification on Crab and Clam Shells

Bailey Turnicky

As the ocean becomes more acidic, many shelled organisms must work hard in order to create their shells while some lose their ability to make them altogether. With many ecosystems and economies dependent on the use of oysters, clams, and crabs, we cannot afford to let these creatures go extinct. This experiment compares clam shells and crab shells in acidic conditions. I hoped to learn whether ocean acidification (OA) really affected different shells differently? To determine whether or not OA affected the composition of clam shells and crab shells, I compared the initial mass to the final mass to see if there was any significant difference. 30 of each type of shell were used as the control group, and placed in a tank under normal oceanic conditions, meaning the water had a pH of about 8.25. The other 30 of each type of shell were used in the experimental group, and were placed in a tank with a pH of about 8.15. All other variables were kept constant. The OA had a greater impact on the clam shells than the crab shells. The average initial mass for the clam shells was 100 grams, while the average final mass was 90 grams. The average initial mass for the crab shells was 125 grams, while the average final mass was 121 grams. In addition, the clam shells overall looked more visibly deteriorated, while the crab shells appeared to be in better condition. After doing a chi squared test, so the results were not just due to chance, disproving the null hypothesis. More research is needed to better understand why some shells, like crustacean shells, are better able to fend off the effects of OA.


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## Embedded Systems (900)
## Robotics & Intelligent Machines (1900)

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Testing Transistors by Taking Elements of the Design of Multi-Polar Neurons

Caitlyn Carver

The purpose of this study is to attempt to understand the multipolar effect at the level of transistor logic and integrated logic by testing the effects of integrated logic between two types of same logic gates on a particular circuit. Two circuit boards are hooked up to a tiny computer: one circuit is with the multiple transistors and the other with one multi-emitter transistor. The computer will collect data from both circuits to test which design is more efficient. The IV is the transistors that affect the ID the data that is produced through the computer, while the controls will be the methods of making the transistors and using the same materials throughout the entire experiment. The hypothesis predicts that the multipolar transistor circuit will be more efficient than the series of bipolar transistors. The data supports the hypothesis with the statistical tests performed. By graphing the amps, resistance, dispersion, and variation it concludes that the multipolar transistor circuit was more efficient overall. The data shows that the physical and logic behind the transistor, relating to a multi-polar neuron, was correct. Sources of error include when making the transistors, flaws in the soldering of the circuit, and length of wires.

Through the experiment, by applying the same logic that comes from the biological wiring to our own computer, could improve our own systems. So what can be done to improve our hardware and software through this? By taking more time into researching into neurons and how they work together and applying it to our computers. Also could taking the research to evolve integrated logic on a physic and logic approach. Also further research include the energy through a neuron and how it uses less energy than the wires we use. Could be put into wires we have today?


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High-Strength Artificial Polymer Muscles

Jacob Helmann

With the rapid expansion of robotics and prosthetics, there is a need for a new and more efficient type of “muscle” to control them. The typical artificial “muscle” that is used is both cumbersome and inefficient. A new type of artificial “muscle” made of individually-coiled fibers could be used in a diverse range of applications; they are not only smaller and more energy efficient, but also even stronger than current artificial “muscles”.

The purpose of this research was to determine what the most effective type of filament to use in these “muscles” is. Nylon 66, Kevlar, and polyethylene fibers were all made into coiled “muscles” and tested. The fiber was first secured to a drill and twisted and, before it began coiling, a copper wire was wrapped around it. The now multifilament “muscle” was then coiled around a mandrel and annealed in an oven to set the new shape. The contractile strength was tested by suspending a weight and heating the muscle, then measuring the distance lifted. Tensile strength tests were also conducted by increasing the amount of weight until the “muscle” tore. It was found that polyethylene provided the most favorable balance between contractile and tensile strength when compared with the nylon and Kevlar. A coiled polyethylene “muscle” is far more compact and lighter than traditional hydraulic “muscles”, which would be useful when precise movements are required. Further research could test other types of filaments and improve the ease of constructing these muscles.


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Use of UAVs for Field Trial Analysis of Nursery Crops

Abigail Hemby
Travis Hineman

Unmanned aerial vehicles (UAVs) are gaining approval and usage for a wide range of natural resources, management applications, and geospatial research. UAVs’ cost effectiveness has advantages over satellites and piloted aircraft to potentially assist growers in monitoring and managing crops effectively in agriculture. In this experiment, two forms of data were compared to determine if the use of UAVs could be a more efficient method of receiving data than manual data collection. The number of blooms and average diameter of each plant were manually calculated. The same data was collected using aerial imaging from a DJI Inspire UAV with a X3 FC350 camera at 45 feet. Photoshop was used to find the number of pixels with the same RGB values of the bloom varieties. The mean, standard deviation, median, and area was calculated for each variety in the laboratory and was compared with the mean, standard deviation, median, and area of each flower variety from the data collected from four UAV pictures, each containing 45 plants. The mean of the manual collection for the white pansies was 4.31, in comparison to one mean collected in one picture, 4.27. The manually collected area was 5561.58cm² in comparison to 2276cm². The mean of the manual collection for the red pansies was 6.2, in comparison to 1. The manually collected area was 4596.35cm² in comparison to 2916cm². The mean of the manual collection for the yellow pansies was 2.73, in comparison to 1.4. The manually collected area was 5681.18cm² in comparison to 4737cm².


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Exploring the Possibility of Using “Green” Nanoparticle Synthesis Methods to Catalyze Direct Methanol Fuel Cells

Brendan Gallagher

Using metal nanoparticles made using biological extracts as catalysts in direct methanol fuel cells is a new idea. This would eliminate many issues with present-day catalysts, including cost and safety. In this study, Xanthan Gum and palladium chloride are used to synthesize palladium nanoparticles and compared to commercial palladium nanoparticles in terms of catalytic efficiency. Efficiency was determined by applying both the commercial and “green” palladium nanoparticles to a graphite electrode and performing cyclic voltammetry tests. FTIR scans indicated a successful synthesis of the green nanoparticles. Currently, catalytic efficiency data collection is still ongoing.


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Using C4 and Invasive Plant Species as a Source of Second Generation Biofuels

Sean Lohr

Nearly half of the corn produced each year is used to produce ethanol instead of serving as a valuable food supply. Scientists are seeking alternative sources of both glucose and cellulosic enzymes so that arable land can be reclaimed for farming food crops. One potential solution is to use non-native, invasive plant species as well as C4 plants, since they grow rapidly and inhabit land often unsuitable for farming. The C4 and invasive plants selected for this study include Digitaria spp., Phyllostachys spp., Elaeagnus umbellate, and Euphorbia maculata with corn as the control. These plants were treated with cellulase and subjected to the Benedict’s test. Absorbance of the supernatant was then measured at a wavelength of 735 nm to compare the levels of glucose in each of the plant solutions. E. maculata and Digitaria spp. had the same mean absorbance as corn, 0.43. Calorimetry was then used to determine the calories/gram for the dry ash weight of the Digitaria, E. maculata, and Phyllostachys. A single factor ANOVA was performed and the p-value is equal to 0.00000825 with 23 df, thus rejecting the null hypothesis which stated that there is no significant difference between the energy produced by corn or any of the test samples. Rather, the findings indicate that Phyllostachys has over five times the calories/gram compared to the other samples. Extensions include examining natural enzymes, such as fungi, that can hydrolyze cellulose at multiple sites on the molecule, since this is currently the most cost prohibitive step in the production of biofuels.


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Optimizing Hydrogen Production of Chlamydomonas reinhardtii Using Titanium (IV) Oxide Encapsulation

Raghava Pamula

When algal species Chlamydomonas Reinhardtii is subject to anaerobic conditions, it switches to a form of respiration in which hydrogen gas, a clean, efficient fuel source, is produced. In past research, titanium (IV) oxide encapsulation has been shown to increase the hydrogen production by C. Reinhardtii because the titanium (IV) oxide encasing re-emits light at a frequency that catalyzes hydrogen production. Additionally, when the titanium (IV) oxide concentration used to encase the cells is too high, the cells fail to reproduce and the algae colony fails to grow. It is hypothesized that there is an ideal concentration of titanium (IV) oxide that can be used to encapsulate the algae that will minimally hinder its growth while still enhancing hydrogen generation. To test if there is a relation between hydrogen production and titanium (IV) oxide concentration, algae encapsulated with varying concentrations of titanium (IV) oxide (15%, 20%, 25%, 30%) were placed in flasks which were connected to eudiometers filled with water. The volume of gas produced was found by measuring the volume of water displaced. Data collection and analysis continues, but it was found as a general trend that as titanium (IV) oxide concentration used to encapsulate the algae cells increased, so did moles of hydrogen gas produced. This implies a direct relationship between the concentration of titanium (IV) oxide used to encapsulate algae such as Chlamydomonas reinhardtii and the amount of hydrogen gas produced up to 15%. Research continues on this trend with increasing titanium (IV) oxide concentrations.


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The Effect of Environmental Stress on Oil Production of Nannochloropsis oculata Algae

Shrayanshu Singh

The need for alternative sources of energy is increasing due to depletion of fossil fuels. Algae are organisms that are readily available, can be manipulated in multiple ways and produce lipids/oil. Leveraging algae into an efficient and abundant oil source has many benefits. Previous studies identified that the algae, N. oculata, is an oil producer and as much as 60% of the oil can be extracted. In addition, it has been shown that stress on environmental conditions will result in an increase oil production in algae. Multiple cultures of N. oculata were grown for two months. A culture was stressed with carbon dioxide bubbling into a jug, to increase the amount of dissolved carbon dioxide. A separate culture was stressed in a medium with reduced levels of nitrogen.

The extraction of the oil was accomplished in two phases. In the first phase, sodium hydroxide was added to release cellular contents. In phase two vegetable oil was added to create oil extraction. The phases were allowed to separate, and collected oil was measured. The oil production was greater in the reduced levels of nitrogen than in the control or in the carbon dioxide. Thus, lower levels of nitrogen will be used as the most efficient producers of oil. Research will be needed to determine how more oil can be produced on a major scale.

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An Investigation of Exoelectrogenic Microbial Communities and the Effect of pH on the Performance of a Microbial Fuel Cell

Ryan Taylor
Minh-Tam Tran Le

Sustainable sources of energy are necessary to combat the impending energy crisis. Microbial Fuel Cells (MFCs) are promising sources of renewable energy. They consist of anode and cathode chambers separated by a semipermeable membrane, and use anaerobic respiration of microbial communities to produce an electric current. The purpose of this investigation was to study the outputs of various soil-based microbial communities and any correlations with pH. Experimentation was divided into three stages; in each, the dependent variables were energy output and pH over time. Stage I investigated various microbial communities within soil samples from a stream, marsh, and compost. The control was identical but without a soil sample. ANOVA tests indicated that there was no difference in energy output between the bacterial communities. Stage II used a constant microbial community sample, compost, but variable pH through buffers. The control had equalized pHs of seven in both chambers. A t-test indicated significant change in energy output, but only an acidic cathode chamber yielded energy increase. Stage III investigated electrical current created by pH differentials alone, without bacteria. The control had equalized pH and no bacteria. A t-test yielded a significant difference from the control, whereby higher pH differentials yield greater energy output. For each stage, the hypotheses were that conditional manipulations affected energy output, but the investigation indicates that only pH has an effect. Therefore, MFCs could be versatile energy, utilizing various microbial catalysts. Further research could explore applications of pH differentials for energy production and specific strains of exoelectrogenic bacteria.


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Viability of Water Hyacinth in the Production of Ethanol

Jacob Turner

Water hyacinth is an aquatic plant native to the Amazon of South America. In the late 1900’s, it was introduced to the southeastern United States as an ornamental plant. When it was released into rivers in Florida, warm temperatures combined with the presence of virtually no predators resulted in an explosion in growth of the plant. To this day it remains an issue, as it clogs waterways and chokes out native plant life. In order to combat this, I set out to synthesize ethanol from water hyacinth biomass. If the process is efficient enough, the water hyacinth removal could be propagated with little energy input. The ethanol production process began with heating a water hyacinth slurry to 160 degrees Celsius for 20 minutes in the presence of sulfuric acid. After the pH was stabilized, yeast was added to the solution and was given two days to ferment. The ethanol content was then determined using a Brix refractometer. This value could then be compared to known ethanol outputs of corn stover and cane stover, both cellulosic biomass sources. In preliminary trials, the yeast was either dead upon contact with the solution or the glucose content of the solution was too low to sustain the fermentation process. When the percent alcohol of the solution was measured, there was no change in the density of the solution. This indicates that there was no ethanol present in the solution.

http://cmscert.engr.ucr.edu/research/ses/wymanpublications/Pretreatment%20The%20Key%20to%20Unlocking%20Low%20Cost.pdf

http://ucanr.edu/datastoreFiles/234-1388.pdf

http://edis.ifas.ufl.edu/ae493

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The Women, the Myth, the Engine: The Effect of Alternative Fuel Solutions on the Cleanliness of the Exhaust Produced by a GEET Plasma Engine

Donna Heivilin
Hui Yu Juan

GEET plasma engine was invented to run on alternative fuel. This research aimed to study how alternative fuel solutions affect the pollutants in exhaust of GEET plasma engine. Independent variable was type of alternative fuel solution (sugar-water, salt-water, fish oil-gasoline, vegetable oil-gasoline, and gasoline-water), and dependent variable was amount of pollutants (CO, CO2, HC, and NO) in exhaust. Control group was amount of pollutants in exhaust when gasoline was used, and constants included reactor direction, alternative fuel amount, and duration of emission test per trial. First, a single-piston lawn mower’s engine was modified, and each of the solutions was tested for viability. The engine was then taken to “Virginia Regional Transit” to measure its emissions for each alternative fuel. There were least amount of CO2 (9667 ppm) and NO (28 ppm) with gasoline used, CO (12300 ppm) with fish oil-gasoline used, and HC (846 ppm) with gasoline-water used. The null hypothesis stated that type of alternative fuel solutions introduced to GEET plasma engine had no effect on cleanliness of exhaust. In context of CO, NO, and HC, the p-values of 0.592, 0.096, and 0.169 from ANOVA single factor test was above significance level of 0.05, which wouldn’t reject null hypothesis. In context of CO2, the p-value of 1.31 x 10^-8 rejected null hypothesis. Thus, the alternative hypothesis, which stated that alternative fuel solutions would produce cleaner exhaust than gasoline, wasn’t supported. Results suggested that gasoline produced significantly less CO2 than other alternative-fuel solutions tested, but differences in levels of CO, HC, and NO between tested alternative fuel solutions and gasoline were insignificant. For further research, individuals could focus on testing more alternative fuels and modifying different engines.


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The Effects of Different Wire types in Permanent Magnet Motors

Trenton Morrell
Matthew Nekic

The purpose of the experiment is to test various wire types in alternators to try and produce the highest electrical output possible. The independent variable in the experiment is the wire type (silver, aluminum, or copper) and the dependent variable is the electrical output that is produced from these wires. The experiments control is the standard copper wire used in common alternators. The experiment was designed by disassembling used alternators and removing the copper wires from the stator. Once the standard wire was removed, new wires were wound around the stator. Throughout the experiment there was an ongoing trend. The silver wire had the highest electrical output while the aluminum wire had the least. The copper wire, however, produced the most consistent and steady output. The hypothesis of the experiment is that silver and aluminum wires will produce more electricity than copper. The hypothesis was true in the fact that the silver wire produced more electricity, but also wrong due to the aluminum being the least conductive. Some sources of error may be the winding techniques used during the experiment. Another source may be due to the inconsistency of the wires. Some further research may be to test different metal wires (such as gold or zinc) or perhaps superconductive wires.


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The Effect of Thermal Energy on Hand Temperature While in a Skiing Environment

Eric Betsill

Skiing is a sport loved all around the world even through some of its shortcomings, chief of which is the cold weather, the number one reason that athletes leave the sport. By introducing a heating mechanism in the ski pole, the problem of pain in the fingers caused by the cold is solved. The modified pole was the independent variable, compared to a standard ski pole control of the same length through 50 different temperature readings that represent the dependent variable. The temperature on the inside of each glove every 5 minutes while skiing an evenly distributed difficulty of slope would determine the success or failure of the heated ski pole design. Results show that on average the heated pole hand at 22.35°C is an average of 6.088°C warmer than the standard ski pole control at 16.27°C, which was sufficient to ward off pain from the outside temperature. With a p-value found in my T-test reported a value less than .05, the two variables have a strong correlation, and after looking over the data, it is safe to say that the original hypothesis, stating that the introduction of a heating element to a ski pole will remove the pain from a skier’s fingers, is supported. There is a future for marketing this technology, seeing as how it is the first of its kind and how common the problem is that it aims to fix.


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The purpose of this project was to test various styles of modern fin designs, in terms of stability and aerodynamics, to see if the fins could be further evolutionized. By doing so, our intention was to further enhance modern fin designs for a new age of space technology. To determine aerodynamics and stability, each fin was run through a virtual wind tunnel software (Autodesk Air Flow) to measure average coefficient drag, wind velocity, and drag force. In addition, data on wind turbulence was recorded and observed to further determine stability and aerodynamics. The project itself had three primary stages, each building off the last. At the first stage, there would be three fin designs along with a control (a standard parallelogram rocket fin). The best performing fin, based on the data analyzed above, would move onto the next stage. At stage two, the winning fin from stage one would become the new control and would be redesigned or evolutionized into three more fin designs and tested yet again. This process would continue once more to create three stages of evolution.

Currently we have tested and found that three fins are better than four fins on a rocket because they decrease profile drag by 27.8% on average. In stage one, we have found that the parallelogram shaped fins with a cylinder attached to the end provide the most stability, but lack in aerodynamics. The control fins however provides better aerodynamics, but causes more turbulent airflow rather than laminar airflow, indicating instability.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS. EFFECTS OF STABILIZING FINS AND A REAR-SUPPORT STING ON THE BASE PRESSURES OF A BODY OF REVOLUTION IN FREE FLIGHT AT MACH NUMBERS FROM 0.7 TO 1.3. BY ROGER G. HART. LANGLEY FIELD: N.P., 1952. PRINT.
OTHMER, CARSTEN. "ADJOINT METHODS FOR CAR AERODYNAMICS." JOURNAL OF MATHEMATICS IN INDUSTRY (2014): N. PAG. RPT. IN ADJOINT METHODS FOR CAR AERODYNAMICS. N.P.: N.P., N.D. N. PAG. PRINT.
U.S. ARMY. U.S. ARMY AVIATION AND MISSILE COMMAND. EXPERIMENTAL INVESTIGATIONS OF GRID FIN AERODYNAMICS: A SYNOPSIS OF NINE WIND TUNNEL AND THREE FLIGHT TESTS. BY DAVID WASHINGTON AND MARK S. MILLER.

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Identifying Characteristics of Buildings that Indicate Seismic Vulnerability Using Satellite Images

Jonathan Kerr

Cities located in regions with high frequencies of earthquakes depend on building vulnerability assessments to plan evacuations routes and prepare buildings for earthquakes. Using only a satellite image to perform these evaluations may lead to faster, less expensive, and more frequent vulnerability assessments. To demonstrate this application of satellite imagery, a satellite image of Kathmandu, Nepal, from before the 2015 earthquake was obtained, along with ground data on building damage from after the event. This data was loaded in ArcGIS, and a region within the satellite image was chosen which encompassed buildings which received diverse damage from the earthquake. Within this region, each’s building’s location and geometric properties were measured by tracing a polygon around the structure and by using ArcGIS’s calculating geometry function provided within the corresponding attribute table. These polygons were input into ArcGIS’s image analysis to calculate the spectral properties of each roof. Roof position and shadow length were used to calculate building height. These properties were then analyzed to find patterns which corresponded with building damage.


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Determining Stress Strain Curves of Three-Dimensionally Printed Materials and Their Infill Patterns

Grant Kim

Standardized data on mechanical properties of materials is sine qua non for any reliable engineering design. Without reliable data on the mechanical properties of the materials, 3-D printing of models are more decorative rather than utilitarian for engineering needs, since it will have no valid basis for comparison between materials and infill patterns. This research measures and compares the young's moduli – one of the significant elastic properties – of 3-D printed samples with identical dimensions but with various infill patterns, densities, and materials. This standardized data will enable inclusion of elastic properties in optimization of engineering designs. This research measures the Young’s moduli of ABS, PLA, PVA, Nylon, HIPS, Polycarbonate, and Bendlay, with various infill patterns of Linear, Rectilinear, Octagonal, Honeycomb, Concentric, Archimedean Chord, Hilbert Curve, with a density of 80%, using the Mark 10 ESM-303, which provides industry standard reliable data that can be used by design engineers. Future research will include various densities, same materials from different manufacturers, and different printers from different manufacturers.


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The Effect of Wing Surface Modifications on Elliptical Wing Stall at Different Angles of Attack

Derek Mamrol

Elliptical aircraft wings are known to have extremely low drag for a given aspect ratio, but suffer from undesirable stall characteristics that lead to little time for a pilot to correct before stalling. Delaying the onset of stall for elliptical wings could therefore allow pilots to operate elliptically winged aircraft in a wider range of angles of attack without stalling, making the elliptical wing form, known to be highly efficient, viable once again as planes using this wing form have not seen wide use since the mid 20th century.

This research employs 'surface modification' technologies such as vortex generators and surface dimpling in an attempt to delay stall through delayed surface boundary layer separation at different angles of attack. Wings derived from a base control wing in Autodesk Inventor are tested through a simulation conducted in Autodesk CFD. After simulation testing, results are analyzed to determine whether or not a specific surface modification shows potential for delaying boundary layer separation. The modifications that display promising simulation results will be printed using a 3D printer and tested in a wind tunnel that mimics the conditions in the simulation. This research is currently ongoing.


Fully Portable Electromagnetic Load Movement Prototype

Alexander Rodriguez

The engineering goal of this project was to design and prototype an electromagnetic device capable of supporting the average human weight. In addition to supporting a human, the electromagnetic devise would also assist users in the handling of steel and iron materials. Versatility was considered in the design of the device, allowing it to have practical application for military use, construction sites, shipyards, and as a recreational device. The design of this device was engineered to meet the following requirements: To be fully portable and not attached to an AC outlet, to be able to hold more than 154lbs (Average Human Weight), allows the device to be powered on and off, the device’s power source small enough to be contained within a back pack, and to have two independent electromagnetic systems. Each electromagnetic system consist of a rubberized handle accompanied by two electromagnets that are then powered independently from a battery bank within the backpack. An electromagnet is a coil of wire that is wound around an iron core. When an electric current passes through the coil a magnetic field is produced. The magnetic field can be shut off when the current that passes through is turned off. The prototype of this device is only one of many ways electromagnetism is being used today. Thus far the prototype has successfully supported 170lbs in a downward force test trial. This was accomplished with both electromagnetic system and then with only one independent electromagnetic system. A successful vertical plane movement test would be the next step in taking the project further in addition to creating a smaller, more efficient power source as well as acquiring stronger, smaller electromagnets.


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The Effect of Headlight Bulb Type on Driver's Visibility

Cameron Smith

This study’s aim was to support the hypothesis that the installation of xenon bulbs in a certain type of obsolete automotive reflector-style headlights is unsafe, in comparison to the application of a xenon headlight bulb in its intended projector housing. The market is abundant with xenon bulbs that are designed to fit with no modification into reflector style headlights. Xenon bulbs create intense, white light that can be very blinding to other motorists at night. It is required that all stock high intensity discharge xenon headlights come with a light cutoff to prevent blinding others, which was clearly seen in the drop in light intensity at the cutoff in testing. Reflector style headlights, however, are not designed to have a cutoff, because they were originally used with far less intense light sources, such as halogen bulbs. This causes them to throw light randomly, regardless of their possible conversion to be far more blinding. This was clearly seen in the large light pattern thrown by the reflector housing in testing. This scattered distribution of light causes extreme glare for other drivers at night. Glare blinds drivers at night by scotomaptic disability (retinal information overload), decrease in contrast, fatigue, and squinting. This can lead to fatal crashes, making the improper use of xenon bulbs a serious topic.


Flannagan MJ. Subjective and objective aspects of headlight glare: effects of size and spectral power distribution. Ann Arbor, MI: Transportation Research Institute, The University of Michigan, 1999.


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# Environmental Engineering (1300)

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Localized Accumulation of Lead in Sunflowers

Isabel Berrios

One form of bioremediation is the use of plants for soil clean up of contaminating toxic heavy metals. Industrial waste and nuclear accidents have been a primary source for this soil pollution. Sunflowers have been identified as hyperaccumulators of these contaminants. Seedlings were grown for 60 days then replanted into three different concentrations of lead contaminated soil. The plants were segmented by region, dried, and crushed then suspended in water for testing. To test for the presence of lead, a qualitative toxicity assay using baker's yeast was employed. The control set of lead concentrations were used as a reference point for viability in the test tubes. A white, creamy color indicated little to no viability while a darker pink indicated some degree of viability. The root segments contained a demonstrative amount of lead as shown by the assay. The stems and leaf portions provided inconclusive results to the presence of lead, but a closer microscopic inquiry is needed. Further research could be performed with longer exposure to lead by more mature plants.


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Fog Harvesting as a Source of Clean Water in Developing Countries

Megan Donovan

More than 3.4 million people die from water-related diseases acquired by consuming contaminated water. Often bacteria and other contaminants such as giardia (a common intestinal parasite) are present in polluted water. Access to clean drinking water can be difficult to attain in developing countries which is why many people collect rainwater which is often safe to drink.

The purpose of this research was to construct a device that could be used to harvest fog as a water source. The device was placed in a steam room for approximately one hour intervals. Relative humidity was noted as well as was the amount of water collected. This was repeated 15 times. On average 25.1 milliliters of water was collected per hour. The goal of constructing a collection device was successful, however, further research is necessary to determine the minimal humidity necessary to collect sufficient amounts of water. In addition, exploration of device placement which would provide optimal water collection is important. This is a novel, cheap way in which to provide water for those living in developing countries.


Mealworms vs. Waxworms on Plastic Consumption

Kendra Giles
Rachel Hollatz

Plastic pollution is threatening the environment, because plastic never biodegrades. Instead plastic photodegrades, which means it will break into smaller pieces without ever breaking down chemically. The result of photodegradation is an abundance of nurdles, virtually invisible pieces of plastic. Nurdles are commonly consumed by filter feeders and other marine animals, which puts them in danger of intestinal blockages and poisoning. The best way to prevent nurdles is by developing a safer way to digest plastic. Scientists have found different species of worms known to digest plastic. We decided to test two different types of worms: mealworms and waxworms, and two types of plastic: polystyrene and polyethylene. Our goal was to determine which worm was more effective at consuming each plastic. 100 mealworms were placed in a tank with 25g of polystyrene and 25g of polyethylene. 100 waxworms were placed in a separate tank with 25g of polystyrene and 25g of polyethylene. The plastics were weighed roughly every week to determine the mass. One of each block was soaked in water so that the worms would have access to liquid. The waxworms died off quickly and barely ate either type of plastic, in fact, for reasons we cannot explain, the final mass of the polystyrene and polyethylene were 25.31 and 25.16 (respectively). The mealworms had a lower death rate, and the final mass of polystyrene was 22.67, and the polyethylene weighed in at 24.42. We concluded that mealworms were the most efficient at consuming plastic, especially polystyrene. Our data was slightly skewed from the waste discarded by worms, as well as the worms that burrowed into the plastic that we could not remove. More data should be collected with a scale of higher precision in a more organized manner for accuracy.


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Determining the Potential Secondary Impacts Associated with Microorganismal Biodegradation of Microplastics in the Marine Environment

Mehr Kumar
April Xie

Microplastics, particles up to 5mm in size, account for 80% of the 8 million tons of plastic pollution introduced to the oceans annually. Persistent organic pollutants (POPs) are chemicals found in low concentrations throughout the oceans and do not degrade easily. However, they concentrate on other hydrophobic substances, specifically microplastics, and then bioaccumulate up the food chain. Previous research indicates that marine microorganisms are capable of degrading microplastics in the marine environment. This study explores the degradation products of biodegraded polyethylene terephthalate (PET) microplastics by microorganisms in the marine environment. The leftover trial water following biodegradation of microplastics by two marine-native microorganisms, one species of bacteria and one fungus, was tested using the Fourier Transform Infrared Spectroscopy (FTIR) to separate and identify any remaining substances. Among the identified substances, polyethylene and dioctyl phthalate, a primary plasticizer, were prominent throughout all trials. Current trials have provided no evidence to suggest the release of harmful products from the microplastics due to biodegradation. Additional research includes FTIR analysis of the contents of lysed microorganisms following their biodegradation of microplastics. Therefore, research determining the feasibility of using marine microorganisms as a means of biodegrading microplastics in the marine environment is currently in progress, and more conclusive data is forthcoming. This method can replace current disposal methods of commercial waste prior to its entry into waterways and ultimately translate to the reduction of marine organism deaths caused by plastic pollution and the toxins they carry by preventing the introduction of POPs to the food chain.


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The Effect of Riparian Buffer Zones on Macroinvertebrates

Lindsey Long

Riparian buffers are key to helping keep pollution out of important watersheds. The purpose of this study was to describe diversity and population of macroinvertebrates in five different streams in Loudoun County with different types of urban impact. After verifying the riparian buffer zones, macroinvertebrate screening was conducted. At Site 1 sampling area, Zone 1, Zone 2 and Zone 3 existed. The following data was collected at Site 1, 138 organisms were found. Of these 138, 104 were sensitive to pollution; 21 were moderately sensitive; and 8 were tolerant to pollution. From Site 2 that contained Zone 3, 113 organisms were collected. Three were pollution sensitive organisms; 82 were moderately sensitive organisms; and 28 were tolerant organisms. From Site 3, which contained Zone 1, the following data was collected: 31 total specimens were caught; 1 was sensitive; 3 were moderately sensitive; and 27 were tolerant. Site 4 contained Zone 1 and Zone 2. Here, 128 macroinvertebrates were retrieved, of which 4 were sensitive; 54 were moderately sensitive; and 70 were tolerant. Site 5, where 105 macroinvertebrates were found, contained Zone 1 and Zone 3. At this site, 1 organism was sensitive; 59 were moderately sensitive; and 45 were tolerant. These results supported the hypothesis by showing that the site with all three buffer zones had the greater macroinvertebrate diversity and population. The hypothesis could be strengthened by having more test sites. A test to further this experiment would be testing how plants affect the quality of riparian buffers.


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Using Excess Woodshop Materials for Oil Reclamation

Jerin Manalel

Oil contamination is a major problem due to excessive contamination of the environment. Methods of oil cleanup include bioremediation, burning and skimming. Typical cleanup efforts combine multiple methods due to availability of resources, and effects of each method on the environment. Focusing on containment and skimming techniques, this study tests the absorptive abilities of woodshop waste shavings. Different samples of wood were isolated from stock within the school woodshop. Each sample was then tested to determine degree of absorption by measuring the maximum absorption of each sample in an oil only environment. This absorption value is a ratio, grams of oil absorbed per gram of wood. The types of wood tested in initial assays were; pine, poplar, walnut, ash, and cherry. The absorption of oil was greater in the softwoods than in hardwoods, with pine having the greatest oil absorption. Thus, pine will be used as the absorptive material in the oil remediation mechanism. Further research can explore how different sized granulations will affect the absorption value for each wood source. Research will be needed to determine how the wood waste can be processed for major scale use.

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Effect of Plodia interpunctella larvae and associated enzymes on the biodegradation of polyethylene plastics

Elizabeth Manero

Accumulations of plastic in the environment often end up in landfills or oceans where they will remain for years. Plastic however, doesn't biodegrade, instead it breaks down into smaller and smaller pieces that absorb toxins from their surroundings. Waxworms, the larvae of Plodia interpunctella, have been found to eat through plastics like polyethylene film. As the name suggests, their natural diet consists of wax. Few other animals possess such an affinity for consuming wax, but one bird, the lesser honeyguide (Indicator minor), has had its diet carefully monitored due to its large consumption of wax even when other food options are available. While researchers aren’t sure what mechanisms within the bird’s body are responsible for this unique ability, they have documented the presence of certain enzymes within its body. Over the course of the experiment, the ability of waxworms to digest polyethylene, as well as the presence of enzymes like those within the lesser honeyguide, were tested to discuss the viability of them as a bioremediation technique.


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Stabilization of Soil Using Arbuscular Mycorrhizal Fungi and Coir Mats: A Solution for Loess Plateau Erosion

Kelly Rodriguez-Vasquez

The Loess Plateau, encompassing seven provinces in China, is composed of arid, deteriorating land and silt, engraved by the monsoon months and the extensively dry months that cause soil erosion. The vast territory that could be utilized for agricultural purposes is unsuitable because the region’s mass soil depletion makes the land unsustainable for the growth of plant life. Geosynthetic methods employed currently seek to prevent mass soil erosion, yet these methods are detrimental to the surrounding environment.

The purpose of this research was to determine which biodegradable technique works effectively in providing soil stabilization in regions such as the Loess plateau. The biodegradable methods employed involved the use of coconut fiber mats and granular arbuscular mycorrhizal fungi. Testing scenarios involved PVC pipes containing soil and grass. These pipes were embedded with coir mats alone, arbuscular mycorrhizal alone, a combination of coir mats and arbuscular mycorrhizal. Control pipes had nothing embedded in them. Water was poured into each pipe and the amount of water exiting was measured. This reflected the amount of water being held by the soil and the erosion control method. The combination of both the granular arbuscular mycorrhizal fungi and the coconut fiber mat demonstrated greater efficiency in providing soil stabilization.

Further research would entail analysis of erosion control based on this method using different plant species. Together these methods would serve to advance research for soil stabilization in regions similar to the Loess Plateau.


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Heavy-oil Displacement via Circular Capillary Tubes in Respect to Oil-spill Cleanup in Large Bodies of Saltwater

Donya Zargham

After the Deepwater Horizon oil spill of 2010, British Petroleum (BP) removed the oil that initially poured into the ocean at a rate of 5,000 to 10,000 barrels a day. Although advancements have created efficient forms of oil production, little progress has been made concerning oil cleanup.

The purpose of this research was to validate a theoretical system comprising of capillary tubes to collect oil residue that has sunk to the seafloor. By connecting the system to a rotating object like a propeller, thrust generated by the propeller can hypothetically overcome water pressure prevalent at depths of up to 200 feet. Most rigs in the Gulf of Mexico are situated in areas of shallow water. The propeller, serving the dual purpose of breaking down oil residue, acts as an impetus that drives the seawater up the capillary system, similar to how osmotic root pressure assists plants’ intake of water.

This research validates such a system through the mathematical study of fluid mechanics. Studying equations such as the Bernoulli equation and the Young-Laplace equation suggests that if the surface gradient of oil residue can be decreased to be nearly negligible, then the gradient in evaluating the fluid’s movement can be assumed to rely solely on saltwater. Further research would entail evaluating time needed for the propeller to run in order to generate a sufficient amount of thrust. Replacing current methods of cleanup with mathematical models that use natural phenomena is an innovative step in restoring marine environments.


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An Alternative Gait-Enhanced Design of an Orthopaedic Mobile Brace

Jessika Amaya
Charlie Shields

In many cases of lower extremity injury (i.e. lateral or medial malleoli fractures, anterior talofibular ligament sprains), the only method of recovery is immobilization of the ankle joint. The use of an orthopaedic mobile brace (Aircast ®) can result in atrophy of the immediate muscles of the effected limb as well as iatrogenic pelvic obliquity. This experiment redesigned the concept of a traditional orthopaedic mobile brace to minimize the shift in hip angles that results in iatrogenic pelvic obliquity. The brace was designed custom for the tester through the use of 3-D imaging software; then printed through the use of a cube printer and assembled. For each trial of testing, trackers were worn on key lower extremity points for aiding analysis. The control variable, tested without any mobile device, established a baseline for natural hip angles. Following the control, trials were run with the standard orthopaedic mobile brace, Aircast ® as well as the modified gait-enhanced design to record the degree of pelvic obliquity in comparison to the natural values. Testing of range of motion was performed with no device, the Aircast ® device, and the gait-enhanced device. The control trials, established by the tester walking with no device across 3 meters while tracking the angles between the hips and knees created a basis of natural angles to use to compare experimental groups. Analysis of results showed that the redesigned mobile brace most closely agreed with the trials wearing no brace and minimized the negative effects of the Aircast ®.


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Effect of Polyacrylamide Alginate beads for Use as Micro Reactors

Ramprasanna Chandrasekar
Pranav Samineni

The purpose of the experiment is to go into depth about the possibility of micro biological reactors. For the experiment, Saccharomyces cerevisiae or yeast was used in fermentation to degrade starch and sugar. The “micro-reactor” will be made out of a mixture of chitosan or polyacrylamide, sodium alginate, calcium chloride, and 5% acetic acid. First, sodium alginate was dissolved and then added to the 0.10 L of water and added to 0.10 L suspension of Saccharomyces cerevisiae. A separate mixture of 2% calcium chloride was prepared. 0.15 L of the mixture containing Saccharomyces cerevisiae and sodium alginate was put into the calcium chloride solution. Second, after solidifying for one hour, the beads were dipped into 0.25% of chitosan solution or 4% acrylamide and kept under mild shaking for 20 minutes with different amount of sugar or starch. The overall product, of the micro-reactors were 3-4 millimeters long. The beads had conclusive results and were able to produce comparable amounts of product as the control. This technology could be used to more efficiently manufacture products.


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The Effects of Various Types of Materials on Wireless Internet Connectivity

Morgan Clear
Spencer Wech

Due to the rise of technology and the trend for users to go wireless, we decided that attempting to improve a technology that is on the rise would be the best possible project. Wireless Internet has a limited range capability and the only way to increase the range is to purchase an expensive wireless repeater, thus opening more vulnerabilities in the firewall. If we could eliminate some of the devices required to extend a signal, it would not only be a more secure network, but would also reduce costs. Our approach to the problem was to take different types of conductors and encase a wireless Internet signal emitter within them. While using a wireless signal testing application on a phone, we were able to identify which provided the best signal conductivity. The results were not as promising as expected, most likely because the antenna for the emitter was not making direct contact with the conductors; keeping the signals inside. The silver foil performed the best as expected, for silver is known to be the best conductor. If the test were to be performed again, the emitter antenna would need to make direct contact with the conductors without the plastic casing in between. If this were to be successful, silver pipes could be run within buildings, extending the signal potentially from the first floor lobby, to the 56th floor executive office.


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Synthesis of Zinc Selenide Quantum Dots via Lumbricus Detoxification Pathways

Andrew Humpton

Quantum dots are nanocrystals which are used as semiconductors. The applications of quantum dots include improving image displays such as televisions, improving efficiency in solar panels, and improving bio-imaging. Quantum dots are usually chemically synthesized which reduces their abilities when used in the field of bio-imaging.

The purpose of this research was to use the earthworm’s (Lumbricus terrestris) heavy metal detoxification pathway to biologically synthesize type ZnSe quantum dots. Worms were placed in soil containing sodium selenite and zinc chloride. The worms were left in the soil for 11 days. After that time period, the worms were dissected and the quantum dots were recovered from the chloragogenous tissue of the worm. The result was an aqueous solution containing quantum dots that, when energized with an ultra-violet light, emitted a green light. Further research would entail what other types of quantum dots can be synthesized using worms and if a way exists in the biosynthesis to change the size of the quantum dot which would in turn change the color the quantum dot emits. This research indicates that the use of earthworms may provide another cheap method by which to synthesize quantum dots.


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The Effect of Chitosan Concentration on Localized Bio Gel Drug Delivery involving Tumor Suppression

Pratyush Kanugula
Deven Upadhyay

In recent years there have been many advances in medicine and health, however tumor suppression is still an enigma yet to be solved by medical experts. However, if cancer can be isolated in the body it is possible that injecting a localized drug can help the patient greatly. Various bio gels were created to help aid the diffusion of a drug through inflicted areas in patients. The effect of chitosan will be tested on the bio gel’s ability to diffuse through the ballistic gel. Chitosan concentrations were tested due to the ability of chitosan have an increased solubility in acidic solutions which permits it to be used in transdermal drug delivery. Ballistic gel will be used as a simulant for muscle tissue in the human body. To evaluate the efficiency of the chitosan-altered bio gels, food coloring was used to track the diffusion of the bio gel through the muscle stimulant. The ballistic gel was created by mixing gelatin with heated water and then, it was refrigerated reaching a rather rigid state. The bio gel was made by using chitosan mixed with potassium monophosphate and potassium diphosphate. The concentrations of chitosan were set by weighing out two, four, and six grams of the substance. With the different concentrations of chitosan’s of 2, 4, and 6%, the bio gel had a decrease rate of diffusion through the ballistic gel because the higher concentration of chitosan will allow less of a passage throughout the medium.


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Viscosity, thermal and electrical conductivity of Iron Oxide nanoparticles dispersed in polyethylene glycol

Apoorva Pendurthi

This experiment was created to test the viability of Iron Oxide (II-III) as an energy transfer medium. Iron Oxide nanoparticles suspended in polyethylene glycol will be a better energy transfer fluid than ethylene glycol, because the metallic nanoparticles have more conductive properties. Currently, research has been conducted in this field in order to test the limitations and functions of the discovery of nanofluids and nanotechnology in general. Research has already been taken in the usage of Copper Oxide nanofluid and serves as the basis of this investigation, however many alterations have been made. Due to Copper Oxide being dangerous as a skin irritant and a nervous system depressor, there is a need for alternatives that fulfill the same needs. In this experiment, Iron Oxide nanofluid fashioned from coalescing Iron Oxide (II-III) and Polyethylene Glycol was analyzed through host of varied assessments designed to assess the viability of the nanofluid as an energy transfer medium. Varying concentrations of Iron Oxide nanofluid will be made for the experiment in order to find the optimal mixture. Thermal energy analysis was used to analyze the heat conductivity of the nanofluid and its viability as a coolant. In addition, an electric conductivity meter (ECM) will be used to measure the resistance of the nanofluid. Lastly, a viscosity test will be performed to provide a comparison to current coolants like Ethylene Glycol and Iron Oxide nanofluid’s use as an immediate alternative.


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Reinventing The Leaf: A Novel Biohybrid Photosynthetic System

Wyatt Pontius

Two daunting problems facing humankind today are global warming and global hunger. Photosynthesis in isolated chloroplasts, which produces carbohydrates and sequesters carbon dioxide, is capable of mitigating both issues. Prior research has yielded scant improvements to photosynthesis. This research builds upon previous improvements utilizing novel innovations.

A two-pronged approach to improving photosynthesis was performed to improve the light-absorption and lifespan of the chloroplasts. ssDNA-coated semiconducting single wall carbon nanotubes (ssDNA-SWNTs) were imported inside the chloroplasts, which were encapsulated inside alginate beads and later embedded within silica gel. Eight unique modification systems with different combinations of the nanotubes, alginate beads, and silica gel were tested. Light absorption, oxygen production, DPIP reduction, and photosynthetic lifespan were measured. The ssDNA-SWNTs expanded the integrated intensity to 384% that of unmodified chloroplasts, subsequently increasing oxygen production and DPIP reduction rates greater than 45% each. Silica gel support increased lifespan from four hours to 37 days. Alginate bead encapsulation alone was ineffective but, when coupled with silica gel support, extended functionality to 6 weeks. The synergistic optically-transparent materials enhanced the lifespan of photosynthesis in chloroplasts while preserving the absorption spectrum. The biohybrid system including all three innovations significantly outperformed the control and the differences in terms of all dependent variables were statistically significant after Kruskal-Wallis and Dunn tests were performed. This system produced 60461% more oxygen over its lifespan than the control chloroplasts. This prototype provides a leap forward in photosynthetic technology and could be deployed to mitigate global warming and terraform Mars.


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Many government and commercial groups are working on missions to send humans to Mars. However, for this to be reality, humans need access to food, water, and shelter on Mars. Food is a major obstacle for colonization due to the Martian soil not containing the nutrients to grow plants. I designed, modeled and 3D printed an aeroponics system to survive and successfully grow plants on Mars. An aeroponics system is a system in which plants are grown using a mist environment and no soil. The system was printed using sand as the medium, rather than the plastic norm, testing the ability for the system to theoretically be printed using only Martian soil. Now, the soil is not the source of nutrients but the material used to print the system. All that would be needed to send on the payload is a 3D printer, small pump, seeds, and nutrient solution; all other resources will be found on Mars. The aeroponics system was designed to be simple, durable, and a singular piece of equipment. The system was tested by placing plants in it and running water through. A fixed amount of water, which can be found on Mars, is mixed with the nutrient solution and then poured in and cycled through the system. When tested, water passed through both the system 3D printed out of sand and the one control plastic-printed system, keeping the plants alive. Plants can live and grow on Mars in this system. The system does need a larger hole at the top to vacuum out the loose sand after printing as well as larger holes in the spray heads for water to pass through more easily. Further advancements can be made by making 3D sand printers more transportable and elongating the lifespan of the aeroponics system.


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<td>What Influences Student Achievement? A Look into the Correlation between Average SAT Score by State and Various Factors: Expenditures per Pupil, Class Size, and Political Affiliation.</td>
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Modified for the Quantum Analog of the Monte Carlo Simulation

Bharut Jain

Monte Carlo methods can be used to greatly improve financial predictions, effectively predict cancer, and simulate artificial intelligences. Classical Monte Carlo methods implemented on binary computers require numerous samples to be calculated independently, leading to high latency between each cycle of the simulation. Quantum computing has the potential to cut down on the time and energy needed to run the simulations, by superposing the samples. The quantum analog of the Monte Carlo simulation was modified and implemented by modeling a quantum computer using the C programming language. The quantum algorithms address three applications: financial modeling, DNA evolution, and artificial intelligence. The algorithms were each run 100 times with 750 million samples of each random variable at each step for 15 steps. Each time an algorithm was run, it returned a slightly different result. The financial algorithms show that Quantum Monte Carlo Options Pricing Model may be better at predicting changes in stock values over time when compared to the Classical Monte Carlo Options Pricing Model, Quantum Black-Scholes-Merton, and Quantum Binomial Options Pricing Model. Further, the quantum algorithms were found to require under 100 computation cycles while the classical algorithms required over 10 billion cycles.


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Application of Turing equations to the Analysis of Gastropod Pigment Production

Megan Nilsson

Alan Turing, a mathematician during the mid-1900s, theorized how animal coats gain their striped and spotted patterns through the creation of reaction-diffusion equations. Turing specifically studied these occurrences in mammals, like cheetah spots and zebra stripes, and justified them through mathematical means. Similar patterns are found throughout the realm of nature, like flower petal arrangements and even ripples in sand dunes. Although these equations are only theories, it can be hypothesized that these results can also be observed in various Conus shells. Patterns observed on shells were analyzed by taking measurements as to length and angle degree. Patterns on Conus textile shells also can be predicted via use of a mathematical rule, Rule 30, which dictates pigment expression based on the cell's current state and the state of its two neighboring cells. Conus shell patterns appear to differ when the genetic makeup of the cells differ, as indicated via through evolution. Through these means, it has become more likely that the theorized reaction-diffusion equations and that other various equations can be applied to explain Conus shell patterns. By analyzing measurements, it was determined that Conus shell patterns appear to follow mathematical equation development, such as Rule 30, as opposed to Turing’s reaction-diffusion equations. Mathematical analysis of biological phenomenon is impactful because it indicates the intrinsic behavior of math within the natural world.


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What Influences Student Achievement? A Look into the Correlation between Average SAT Score by State and Various Factors: Expenditures per Pupil, Class Size, and Political Affiliation.

Angela Snakard
Antonina Thornton

Education is a long-debated topic. There is no magic formula—it is all subjective. This experiment is designed to determine whether various factors (Expenditures per Pupil, Class Size, and Political Affiliation) have an effect on SAT scores. The independent variables in this experiment are the aforementioned factors, while the dependent variable is the SAT scores. In order to see if these aspects of society truly impact the SAT score in a certain area, the change in each was calculated for the expenditures and class size. Average SAT scores from all states in 2008 were compared to Expenditures per Pupil, Class Size, and Political Affiliation of those states in the same year. Those results were then measured against the same factors in 2012, which then demonstrated whether there was a positive or negative correlation.


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An Application of Hawk-Dove Game Theory Strategy to Interspecific Competition between Gut Bacteria Using Quorum Sensing Signaling Molecule, N-(3-Oxotetradecanoyl)-L-Homoserine Lactone

Dawson Brown

The discovery of cell-to-cell communication in bacteria, or quorum sensing, has revolutionized our understanding of bacterial cooperation. Quorum sensing signaling molecules allow localized populations of bacteria to perform tasks, including virulence and biofilm formation, as a single unit. This capacity to act as a multicellular entity gives bacteria a distinct advantage evolutionarily. Recent research suggests that cell-cell communication via signaling molecules also occurs between bacterial species. In order to further elucidate the quorum sensing based interspecific interactions between bacteria, an experiment was designed to measure the influence of Yersinia Enterocolitica’s signaling molecule, N-(3-Oxotetradecanoyl)-L-Homoserine Lactone, on growth in three different gut bacteria: Escherichia Coli, Sarcina Lutea, and Enterobacter Aerogenes. The theory being, that in the presence of another bacteria’s signaling molecule, bacterial growth may be inhibited or promoted depending on its evolutionary relationship with the bacteria secreting the signaling molecule, in this case Yersinia Enterocolitica. For each of the three bacteria, spectrophotometry was used to measure growth in a control group (0mg of signaling molecule) and growth in an experimental group (between .10mg and .25mg of signaling molecule). The results show that N-(3-Oxotetradecanoyl)-L-Homoserine Lactone inhibits growth in Sarcina Lutea and Enterobacter Aerogenes, while promoting growth in Escherichia Coli. These results suggest that quorum-sensing mediated interspecific competition between gut bacteria can be defined by hawk/dove evolutionary game theory, in which organisms fight or flee, or in this case grow or recede. This model supports the theory that our human concept of fight or flight is derived from our ancestors, bacteria.


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The Effect of Various Sanitizing Compounds on the Inhibition of Bacterial Escherichia coli and Staphylococcus epidermidis Growth

Annabelle Casey

The purpose of this microbiological project is to determine which sanitizing substances best disrupt the growth of Escherichia coli (E. coli) and Staphylococcus epidermidis (Staph). In this procedure, eight cleaning substances (Iodophor BTF Sanitizer, Fantastik All-Purpose Cleaner, Purell Hand Sanitizer, vinegar, baking soda, Dial Liquid Hand Soap, Clorox Bleach, and hydrogen peroxide) served as the independent variable. These cleaners had different effects on the growth of the microorganisms, and the zone of inhibition for each sample served as the dependent variable. Some samples were placed in petri dishes without cleaning substances: these samples were controls.

Data was collected and a t-test was performed. Clorox Bleach most effectively killed both the E. coli and Staph samples: the zones of inhibition were infinite. This outcome differs from the original hypothesis, which proposed that the Dial Handsoap would be more effective. The data showed that the hand soap’s zone of inhibition was 261.537 millimeters for the E. coli samples. Thus, the chlorine compounds in the bleach were better at inhibiting germ growth than the hand soap’s benzethonium chloride. The petri dishes without cleaners had zones of inhibition of zero millimeters.

One major source of error for this procedure could be that not enough trials were completed. Further research should include more trials, and explore which types of chlorine-compound-containing cleaners are the most effective at “killing” these microorganisms. In addition, more research should be done on benzethonium chloride, because this compound is suspected of having adverse effects on humans and their environment.


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The Effect of Acyl-Homoserine Lactonase on the Formation of Pseudomonas aeruginosa Biofilm

Abhilasha Chowdhury
Nadine El Fawal

Pseudomonas aeruginosa is the major pathogen that infects the lungs of cystic fibrosis (CF) patients. Once the organisms have adhered to the CF airway, they form a biofilm with a self-produced matrix of extracellular polymeric substances (EPS). The EPS makes the bacterial assemblage resistant to antibiotics as it protects the bacteria from exposure. In order to combat the effects of the pathogenic bacteria, innovative techniques to stop infections the development of biofilm need to be developed.

The purpose of this research was to determine the effect of acyl-homoserine lactonases (AHLs) on the formation of Pseudomonas aeruginosa biofilm, using Pseudomonas fluorescens as a model organism. AHLs target and inactivate acyl-homoserine lactones, which are signal molecules involved in Pseudomonas quorum sensing cascades, which allow bacteria to form a biofilm. Pseudomonas fluorescens was cultured and treated with different amounts of Deinococcus radiodurans cell free solution (CFS) containing AHLs.

Deinococcus radiodurans were cultured in TGY medium then centrifuged at 9000 rpm to obtain a cell free solution (CFS). The CFS significantly reduced the biofilm produced by P. fluorescens compared to the untreated group (Kruskal-Wallis, P less than 0.0001). The effect of the AHLs was dose-dependent, with the biofilm decreasing as more CFS was added. Further research could explore what specific components of the Deinococcus radiodurans CFS, other than AHLs, inhibit biofilm formation.


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The Effect of Natural versus Artificial Antibiotics on Bacterial Resistance

Shadden Elfiky
Katiana Estrada

The purpose of this experiment was to determine how the rate of bacterial resistance, when treated with artificial antibiotics, compared to the rate of bacterial resistance to that of natural antibiotics. The independent variables were the different antibiotics: ampicillin, coffee, garlic, and colloidal silver. The control group was bacterial cultures without any antibiotics. The dependent variable was the rate at which the bacteria became resistant to the antibiotic. In this experiment, Escherichia coli was plated and treated with the aforementioned antibiotics. The rate of bacterial resistance was observed, qualitatively, over the course of three bacterial generations. The data indicates that only coffee and ampicillin were able to inhibit the growth of bacteria; the bacteria developed resistance to the ampicillin, but not the coffee. The mean number of zones of inhibition measured for each variable was: control 0, garlic 0, coffee 4.66, colloidal silver 1, and ampicillin 4.33. A chi squared test was used to test the data in this experiment. The alternative hypothesis that stated if bacteria is treated with natural antibiotics then the bacteria will develop resistance at a much lower rate than when treated with an artificial antibiotic was rejected. Ampicillin was the only variable that caused the bacteria to develop resistance. A chi squared test yielded a p-value of 0.23 which indicates the data is not statistically significant. To further the research done in this experiment, the same experiment could be conducted using an antibiotic commonly used to treat E coli infections.


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Investigating the Bactericidal Efficiency of Different Arrangements of Nanopillars Found on Insect Wings

Meghna Gorrela
Molly Magoffin

Previous research showed that wings of dragonflies, damselflies, and cicadas possessed nanopillars with antibacterial properties. The purpose of this research was to investigate the relationship between insects’ nanopillars and their unique bactericidal efficiencies. Nanopillars have the potential for applications in the creation of antibacterial surfaces; therefore, determining bactericidal efficiencies of various nanopillar arrangements is important. This research was done by collecting damselflies, dragonflies, and cicadas, incubating bacteria on the wings of the insects, and determining the amount of bacteria killed using fluorescent dyes. It was hypothesized that Odonata insect wings kill bacteria more effectively than cicada wings because their nanopillars have more varied heights and spacings; these could be more conducive to stretching bacterial cell membranes. Qualitative data shows that nanopillars on dragonfly, damselfly, and cicada wings do rupture bacteria as seen by clusters of fluorescing red dye, which only stains dead bacteria. Analysis of qualitative data suggests that damselfly nanopillars possess the most bactericidal nanopillar arrangement as opposed to the nanopillars of dragonflies and cicadas. Quantitative bactericidal efficiencies of the insect wings’ nanopillars will be calculated using ImageJ. More trials will be performed with different bacterial strains to determine the extent of the efficiency of nanopillars on bacteria. Results from last year’s research will be used to evaluate the possibility of a link between nanopillar parameters (heights, spacings, and diameters) and bactericidal efficiency. In the future, the most efficient arrangement of antibacterial nanopillars could be fabricated onto hospital equipment or other surfaces that would benefit from being inherently antibacterial.


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Investigating the Inhibitory Effects of Bioflavonoids on Escherichia coli UV-Induced SOS Response System

Sunwoo Hong
Kevin Nguyen

Loudoun County sits at the heart of a region known for the prevalence of Lyme disease. Infecting hundreds locally, Lyme disease causes chronic infections that often go undiscovered in patients. Globally, the development of antibiotic resistance has rendered most antibiotics futile and left patients helpless. Recurring Lyme disease infections and antibiotic resistance may be caused by the SOS response system, a prokaryotic pathway that mediates error-prone DNA repair mechanisms after exposure to DNA-damaging agents. Due to its error-prone nature, mutations leading to antibiotic resistance have been attributed to the SOS response system. The goal of this research is to find a simple way to halt the SOS response in bacteria. Different flavones, a major subclass of bioflavonoids, were investigated for their ability to interfere with the SOS response via repression of RecA, a gene that acts as a co-protease to activate the SOS response. UV-C irradiation at 254 nanometers was used to damage DNA and induce the SOS response in Escherichia coli K-12. An ELISA, conducted at different time intervals after UV-C exposure in the presence of differing flavones, was used to quantify the RecA expression. Data collection is still ongoing. Positive results may suggest that RecA could be a drug target to reduce the development of antibiotic resistance, increase the efficiency of existing antibiotics, and inhibit the recurring Lyme disease infections that plague Loudoun County.


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Decreasing Dimorphic Fungal Pathogenicity via Phenazine Exposure

Suraj Ilavala

Many human infections are caused by microbes such as fungi. Dimorphic fungi exist in two different forms: mold and yeast. Interestingly, some bacteria produce chemicals which can fight infections. Phenazine is a natural antibiotic produced by the bacterium Streptomyces griseus. The purpose of this research was to determine whether phenazine derived from Streptomyces griseus could inhibit the growth of the yeast Saccharomyces cerevisiae. Streptomyces griseus was cultured for one week then centrifuged to remove the phenazine produced. Plates cultured with Saccharomyces cerevisiae were treated with phenazine and incubated for 24 hours. Zones of inhibition were noted and it was determined that phenazine appeared to have some effect in inhibiting Saccharomyces growth. Future research would entail further refining the removal of phenazine from liquid culture and determining what types of dimorphic fungi may be inhibited by phenazine treatment. Since fungal infections affect many organisms, finding novel treatments is imperative.


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The Effect of Copper as an Antimicrobial on Various Types of Bacteria

Kender Poore
Clay Rosales

Copper may be proven to be an effective and almost immediate inhibitor of bacterial growth. The medical use of copper has been dated back to ancient times, but more recent clinical studies have focused on the antimicrobial properties of copper. The purpose of this experiment is to observe the effects of copper on specific species of bacteria, as well as analyzing the success when applying copper strips to the doors of our school. In this experiment, we collected cultures of E. coli, C. pseudodiphtheriticum, E. aerogenes, and B. catarrhalis and incubated them on petri dishes for 48 hours at 35 C. Before incubation, four 6 mm disks soaked in a copper powder/distilled water mixture were placed in each petri dish and a zone of inhibition was measured in diameter for each site, showing the effectiveness of copper on specific types of bacteria. In another part of the experiment, copper tape was placed on a set of exit doors in our school. Around every 48 hours, four spots with copper and four spots without copper were swabbed onto petri dishes and incubated at 35o C for 48 hours. The visual results of the bacterial growths were recorded both qualitatively and quantitatively. Copper tape on doors was replaced sporadically. Although our experiment has shown mixed results so far, further experimentation is necessary to thoroughly justify the effectiveness of copper as an antimicrobial. The results of this experiment could lead to many advancements in finding sufficient ways to prevent the spread of bacterial illnesses.


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The Effect of Disinfectant on the Growth of Bacteria

Julia Rizzo

The goal of this experiment is to see how if how disinfectant is dried on a table, will affect how many bacteria survive. The independent variable is how the table is dried; air dried or towel dried; after the disinfectant is applied. The dependent variable is the amount of bacteria, in this case E coli, that survives the disinfectant. The control is a swabbing bacterium without any disinfectant. The procedure for this experiment involved applying E coli to a table and spraying it with disinfectant. After each section dried, it was swabbed. After three days the colonies were counted. There was not a pattern in the data collected, suggesting that the results may be skewed. The control had a mean of 342 colonies of bacteria. The disinfectant did kill some of the bacteria, because the air dried disinfectant had a mean of 123 colonies, and the towel dried had a mean of 159 colonies. The statistical test supported the hypothesis, that the air dried disinfectant would have fewer colonies. There was also an error with the number of trials, since some of the trials were uncountable. When the towel was being used to dry the disinfectant the soap could have been pushed into other trials, changing the concentration of disinfectant each trial received. Using a blow dryer or swabbing bacteria that is submerged in water would be another possible experiment for the future.


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Influence of the Antibacterial Properties in Cockrach and Locust Neural Tissue on e-Coli

Rithika Surineni
Sumadhavika Yadhla

A major problem has been arisen in the medical community leaving many scientists perplexed; this problem comes with the name of “superbug”. Superbugs are strands of bacteria that are resistant to several antibiotics. The infectious diseases of bacteria such as E.coli and MRSA are also becoming resistant due to the development the superbug gene NDM-1. Fortunately, findings in the insect world show that Cockroaches have antibiotic molecules in their brain tissues that can decimate such bacteria with no toxic risk to human cells. Furthermore, in a military investigation, soldiers who came back the Middle East were sick with strange infections. After this area was examined it came to be known that only the locusts from this areas were infection free. Thus it was hypothesized locust brains, lysates; also have the same antibacterial properties as cockroach lysates that allows them to combat the bacteria. To do this experiment we ground up the brains of locusts and cockroaches and mixed in with sterile disks. These disks were then placed in petri dishes of agar with a k-12 strand E. coli spread. The dishes were left in an incubator of 37 degrees Celsius for 48 hours. We recognized the effectiveness by measuring the diameter of the zones of inhibition. We used the cockroaches a control and compared the data. The neural tissue of the locusts does in fact inhibit the growth of the pathogenic E. coli and also in a more effective way than the cockroach. The experiment is still in progress.


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Copper, an antimicrobial substance, is being considered as a replacement for stainless steel surfaces in hospitals. Copper kills microorganisms by weakening their cell membranes and flooding them with copper ions that produce extremely reactive hydroxyl radicals that oxidize lipids and proteins within cells through Fenton-type reactions that utilize hydrogen peroxide. The purpose of this research was to determine whether copper is an effective killer of Saccharomyces cerevisiae with and without the copper regulatory gene CUP2.

A wild type yeast and a CUP2 yeast knockout strain were grown in test tubes with and without copper wire over the course of two days. The number of dead yeast was counted before and after the copper wire had been added using methylene blue dye to differentiate dead cells from living ones. It was determined that the addition of the copper wire caused approximately eighty percent of cell death among the wild type yeast strain and less than seven percent of cell death in the CUP2 knockout strain. Further research would entail exploring the resilience of the CUP2 knockout strain in the presence of copper especially considering that the CUP2 gene acts as a transcriptional activator for the copper detoxification genes that protect yeast cells from copper toxicity. The efficacy of copper in killing microbes merits further exploration as the transition to copper surface use in medical facilities could prove extremely beneficial because it has the potential to reduce the incidence of nosocomial infections.


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The main purpose of this experiment was to see the effects of ethanol on the dissection of strawberry DNA. Normally, the dissection of strawberry DNA is done with isopropyl alcohol. Knowing that ethanol is classified as denaturalized alcohol, which is poisonous to living things, the experiment will test if the harmful chemicals affect the outcome of the experiment. The IV is the use of ethanol, the DV was how successful the dissection was, and the control group is the use of water. There are three containers with crushed strawberries and each container will receive the same amount of either water, ethanol, or isopropyl alcohol. There must be an adult present during the experiment because ethanol is poisonous and dangerous. Since the data from the experiment was qualitative data, the data had to be recorded based on how successful each trial was with each variable. Ethanol happened to be more successful in dissecting strawberry DNA than isopropyl alcohol. Ethanol had a mean of 5 while isopropyl alcohol had a mean of 3.84. The hypothesis was if ethanol is used instead of isopropyl alcohol, then the outcome of the experiment will be different and the DNA will not be as extractable as the DNA with isopropyl alcohol. This was never supported because according to the stats, ethanol had a higher mean than the isopropyl alcohol.

What did ethanol have that helped it dissect more efficiently than isopropyl alcohol?


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GWASER Creation Through The Synchronized Collapse Of Multiple, Aligned Co-orbital Systems

Athreya Gundamraj

Gravitational waves are ripples in the curvature of spacetime that provide researchers with valuable information regarding the high-energy phenomena they originate from. Although these waves have been recently discovered from merging black holes many times larger than the sun, those that originate from smaller sources are still yet to be studied. This theoretical analysis focuses on whether gravitational waves can be amplified. Co-orbital systems are the basis of this investigation due to their multipole properties. Multiple such systems are aligned to achieve an amplifying effect to generate gravitational waves. An incident wave propagates through this “tunnel”, stimulating the collapse of each system it passes. This collapse produces new gravitational waves which amplify the incident wave by means of constructive interference. This mechanism is referred to as a GWASER: gravitational wave amplification by the stimulated emission of radiation. When an incident wave with strain 10^{-10} passes through five co-orbital systems, each consisting of eight orbiting bodies of mass 2 \times 10^{36} kg, the amplitude of the final wave is a factor of 7.2 greater than that of the incident wave. However, when the mass of each orbiting body is reduced slightly to 2 \times 10^{35} kg, the wave's amplitude increases by a mere factor of 1.008. This sensitive condition between the mass of each body and the net amplification, as well as the relationship between the number of co-orbital systems and the net amplification, are further investigated in this analysis.


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A Comparison of the Spectra of 50 Random Stars to the Spectra of the Sun

Colin Harrigan

The purpose of this experiment was to determine what percentage of stars are similar to the sun. The independent variable is the random stars that were analyzed and the dependent variable is the spectra collected from each random star. The control group was the sun’s spectra, as that is what we are comparing the stars to. The hypothesis was that less than 20 percent of the stars collected would be similar to the sun. This was done using the star analyzer 100 and a telescope camera to record spectra of random stars, and then the analysis of the spectra was done in the R-Spec computer software. The p-value, from a t test was 0.3276 which is not statistically significant. The mean was 8.160 angstroms/pixel for the random stars and the sun’s measurement was 8.5 angstroms/pixel. The null hypothesis was accepted. When difference spectra were collected, by subtracting the stars spectra from the spectra of the sun, it was found that none of the collected stars were comparable to the sun. Further research could be how many planets are within a certain nearby radius of the stars that were in similarity to the sun, if any were discovered, and if those stars were in the “habitable zone”. Also, with more funding and time, a spectrograph of the sun could be collected as opposed to using the one spectra in the reference library of the R-Spec software for more realistic data.


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Flat versus Banked Tracks

Willem Smagh

With indoor track rapidly growing in popularity and multiple new facilities being built each year, athletes should know the differences between flat and banked tracks. Studies have shown that banked tracks allow for faster times compared to flat tracks, but how much stress is put on the body, specifically the lower extremities when running on each? Not only that, how does the difference in stress also relate to the times run in those races? To obtain this information, runners were analyzed coming around the turn before and/or after the apex. Final times on a 200 meter track of men’s 400/500 meter races were taken into account. Since the 400 and 500 races are not compatible, the 500 times were scaled to the 400 times. To determine stress, the positive angle away from 90 degrees was directly related to final times to observe the restriction. A right angle is considered to be the normal angle when running straight. Final results have not yet been totaled, however, with current data it can be concluded that the greater than 90 degree angle between the track and the tibia cause slower final times and occur more frequently on flat tracks. While banked tracks do not ensure the relationship to be 90 degrees, it is much closer than that of flat tracks. In essence, banked tracks should be the tracks of the future because of the opportunity to run faster and the less apparent amount of injuries that could occur.


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## Plant Sciences (1800)

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The Effect of Mycorrhizal Fungi on the Spectral Properties of Glycine max

Adam Broshkevitch

Traditional methods of full field fertilizer application are recognized as wasteful and associated with the eutrophication of water sources however are currently necessary in a world where a growing population puts an increasing demand on the agricultural production system. Mycorrhizal fungi, which live in the growing medium of plants where they participate in a symbiotic relationship assisting in nutrient uptake in exchange for carbon, provide a prospective alternative if managed properly through methods such as manipulating crop rotations and utilizing no till techniques in order to establish and maintain fungal colonization. To facilitate such efforts though, a means of assessing fungal colonization non-destructively and on a broad scale is needed. The assessment of leaf spectral properties using digital photography was tested through this project as a means of quantifying colonization based on the precedent that phosphorus uptake is reflected in leaf coloration and the fungi increase such uptake. Two groups of plants were grown with the independent variable being the inclusion of fungal inoculum in the soil medium. The average red, green and blue values were then calculated for the digital photographs taken after thresholding to remove their backgrounds. A T-test was implemented to compare the RGB values of the plants grown with and without the fungus producing the values 0.1188, 0.8791 and 0.5705. As the p two-tail values calculated were greater than the alpha value, the null hypothesis was failed to be rejected and there was no significant difference. Further research could examine other leaf properties such as petiole length.


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What is the Effect of Antifreeze Carbohydrates on Bonnie spinach and Brussel sprouts?

Nidhi Challa
Sudiksha Kochi

During the Winter, the mention of the words “frost” sends farmers to look for an alternative resource to their crops, to prevent the cold snap from destroying their harvests. This could potentially cause the inability of crops to function, and result in economic damage between the farmer and his source of survival. Therefore, to eradicate this problem, we have decided to conduct an experiment testing different antifreeze carbohydrates, such as sucrose and glycerol, on bonnie spinach and brussel sprouts (the common greens we have decided to use). In order to carry out this experiment, we have first decided to cut the nine, attached units of plants from both the spinach and the brussel sprouts, resulting in 18 plants in total. Then we freezed the plants under different timings, which resulted in the wilting and dying of the crops, and then insert sucrose and glycerol through a peristalsis pump in the stem of the plant, too see the effects of revival in the plant. The significance of the results of the experiment can benefit the farmers, who still have functioning crops during the Winter, and the stores who carry the supply and demand of the crops, running a smooth, allocation of resources between two destinations. More importantly, the goal of this experiment is to help the specific cause of physical damage done to plant growth, and allow plants to survive in versatile conditions, where intracellular ice formation inside the plant's cells could be life threatening.


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Processing Methods for Reducing Cyanide Poisoning Due to Cassava Consumption

Nnenna Ezera

Cassava (Manihot esculenta) is the third largest source of food for people in the tropics, however, without proper processing consumption poses a health risk due to its possession of a high level of cyanogenic glycosides. Consumption of under-processed cassava over time can result in the development of goiter, an enlarged thyroid gland, or tropical ataxic neuropathy, a nerve-damaging disorder, due to cyanide exposure. The purpose of this research was to identify what traditional processing methods were most effective at removing cyanide in the shortest amount of time.

The cassava was processed in three ways: boiling, fermenting, and a combination of fermentation and boiling. Cyanide levels were measured using test strips whose color values were then compared using RGB values acquired in Photoshop. The most effective processing method for cyanide removal was the combination of fermenting then boiling which resulted in the cassava retaining almost no level of free cyanide. Fermentation was second most effective and boiling was the least effective method.

For this research, the South American variety of cassava was used. African varieties of cassava have a considerably higher concentration of cyanogenic glycosides therefore further research needs to be conducted to determine whether the same processing method would be sufficient to reduce the cyanide to a level safe for consumption. Implementing the most effective method of cyanide removal is imperative to prevent health risks to those for whom cassava is a dietary staple.

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The Effects of Biofertilizers on the Accumulation of Green Fluorescent Protein (GFP) in Saintpaulia ionantha

Rachel Franklin
Mahpara Hasan

The formation of edible vaccines is important because many least developing countries around the world have restricted access to vaccinations. This would create a low cost and easily transportable vaccine that could help save the lives of many. We believe if a biofertilizer consisting of rhizobium is inoculated into the soil then the transgenic plant will have a larger accumulation of the foreign gene, green fluorescent protein, because rhizobium is known as a plant growth promoting bacteria that stimulates the production of plant hormones, nitrogen fixation, and in general increases plant yield.

Heat shock transformation is used to transfer the plasmid containing the gene for green fluorescent protein into Agrobacterium tumefaciens. Agrobacterium mediated transfer is then utilized to transfer the gene into twenty leaf cuttings from Saintpaulia ionantha. These leaf cuttings are then transferred into containers with a sucrose medium with ampicillin to facilitate the growth of only the mutated plants cells. Once the roots have started to form a rhizobium based biofertilizer will be injected into the medium of ten plants. After the plants continue to grow, UV light will be utilized to observe the accumulation of green fluorescent protein in the plants with and without biofertilizers. We believe that the gene expression of the green fluorescent protein will be more prominent in the plants that are planted in the rhizobium biofertilizer and thus produce a greater amount of vaccine. Biofertilizers have shown to be a viable option for increasing the yield of desired genes in plants.


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Microbial Fermentation to Produce Bio-Agricultural Products

Alexa Glass
Kelly Modest

Many farmers have under producing plants due to a lack of the fungus penicillium and its unique ability to assist plants in the uptake of phosphorous. This experiment seeks to identify the combination of variables such as temperature, moisture and sugar that allows for the highest concentration of penicillium in the soil. The first challenge was to examine how different substrates will effect the growth, followed by the environmental parameters such as moisture and temperature. Finally, the use of additives and supplemental nutrients was examined to further increase production without oversaturation. A fermenter was used to provide control throughout the experiment and allow individual variables to be tested without concern for external influences. It was hypothesized after research that a warmer, wetter climate will allow for greater growth, which was supported in the results. Further research should be conducted to determine sugar content necessary for the soil to maintain the optimum penicillium concentration.


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Water Quality

Ashley Guardado Ayala
Yassy Zelaya Amaya

In many areas, bodies of water have become contaminated because waste is not being disposed of properly. The number of deaths in the sea life often increased because their home is being filled with waste making it hard to survive.

The purpose of this experiment was to help the ecosystem by testing if vegetation has an effect on water quality including factors such as PH and dissolved water oxygen. The experiment was tested using two tanks and soil leveled on a 45 degree slope. One tank had 8 bean plants while the other did not. When the same amount of water was poured down the slope of the two tanks, the soil would erode. Then using a water probe, the PH and the water oxygen would be tested. There was no statistically significant differences between the means of 7.3560 and 7.4248 for PH and the means of 92.280 and 90.104 for dissolved water oxygen. The statistical test used was the T-test. The alternative hypothesis was not supported because of the little significant difference. The plants had no major influence over the water quality, compared to no plants. In the beginning of the experiment, tablets that helped find the PH and water oxygen were being used instead of a water probe which effected the accuracy of the experiment. Are there any other test to measure water quality?


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The Relationship Between Endomycorrhizal Inoculant and Calcium Nitrate on the Effect of Crop Yield of Brassica oleracea var acephala (Red Russian Kale)

Lauren Munno

The world today is faced with a problem it has never seen before: feeding the ever-expanding population. This experiment presents a possible solution for farmers and growers around the world. In this test four groups of Red Russian kale were tested; one group was the control with no additives; one group was fertilized with calcium nitrate; one group was treated with mycorrhizal inoculant; and one group was treated with both fertilizer and mycorrhizae. The purpose of these groups was to represent the different growing options: plain, untreated crops versus plants that are fertilized, plants with microorganisms, and plants fertilized in addition to being treated with microorganisms. The results expressed an increase in crop yield from the group of kale treated solely with mycorrhizae, which was recorded with 33% more biomass than the control group. The mycorrhizae-treated group resulted in 52% more biomass than the mycorrhizae plus fertilization group. Finally, the mycorrhizae-treated group resulted in 74% more biomass than the fertilized group. After analyzing the bar graph of the data collected, the conclusion was drawn that when mycorrhizae was added to the crop, the biomass increased. Further research could explore the effect of mycorrhizae on other crops, to further support the data that the increase in biomass was correlated to the addition of mycorrhizae before and after germination.


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Development of a Kale and Lettuce Hybrid by Protoplast Fusion

Joelle Nilak
Sabrina Sharifi

Brassica oleracea, also known as kale, is a very nutritional plant that not many people consume. An average American, in fact, only consumes about 2-3 cups of kale a year. Kale is a rich source of dietary fibers, vitamins A, K, B9 and C and minerals such as calcium, iron and magnesium. It also contains omega 3 fatty acids which lowers the risk of coronary heart disease and improves cholesterol. Brassica oleracea can survive and grow rapidly under poor weather conditions. The plant's texture is tough and sturdy, making it hard to chew. Lactuca sativa (lettuce) has very little nutrition; however, it's a much softer and chewable plant making it more common in a moderate diet. It is one of the most consumed leafy plants. A Brassica oleracea cell and a Lactuca sativa cell are isolated separately for the removal of its cell wall using the enzymes cellulase and pectinase. After the protoplast isolation, it is fused to create a somatic hybrid by being brought together close with PEG and integrated with electrofusion. It is then placed in a media to proliferate and result in a callus. The callus is expected to grow into a hybrid plant with the appealing texture of lettuce and necessary nutrition of kale. Project still on going.


2001-2016 The George Mateljan Foundation

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The Effect of Varying Frequencies and Durations of Light on Plant Growth under Simulated Microgravity

Gwyneth Schloer

Experimentation on plants in space has become a more popular area of interest lately, especially on the International Space Station (ISS). As a continuation of research conducted last year, the objective of this experiment was to collect more data on the behavior of plant growth under simulated microgravity conditions. In order to obtain the most accurate results, this year a 2-axis clinostat was constructed as opposed to the 1-axis clinostat used last year. In addition, the variables measured were changed based on conclusions made from the experiment last year showing that plant growth was random under microgravity conditions in the absence of light. The purpose of the experiment this year was to find a way to minimize the amount of energy used in space. The hypothesis was “If the lettuce plants experience special varying amounts of light under microgravity simulated conditions, the plants will grow normally (as if under regular gravity conditions)”. The null hypothesis was “The plants that experience special varying amounts of light under microgravity conditions will grow abnormally (as if under microgravity conditions in the absence of light)”.


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Increasing the Photosynthetic Efficiency of Chlorella vulgaris Algae Using Doped Zinc Sulfide Nanoparticles

Alay Shah
Matthew Traenkle

Photoluminescent nanoparticles have the ability to re-emit light at certain wavelengths that can be useful in different applications. ZnS nanoparticles that are doped with transition metals such as gold and silver have re-emission spectra which are very similar to the absorption spectrum of chlorophyll-a, which is the active chemical in photosynthesis present in green algae. Due to this similarity, doped zinc sulfide nanoparticles may be an effective solution for increasing the amount of oxygen produced by plants by targeting the peak absorption wavelengths (429 and 659 nm) of chlorophyll-a. Doped ZnS nanoparticles were created using Ag and Au as dopants, both individually doped and co-doped, through a chemical coprecipitation method. The NPs were characterized using FTIR and SEM data. 10mg/L of nanoparticles were added to flasks of Chlorella vulgaris algae. Change in percent saturation of oxygen was collected from flasks of control and experimental parameters over 5 and 24 hour trial periods. Data collection continues, but it is hypothesized that the co-doped nanoparticles will increase the saturation level the most as it re-emits at both 424 nm and 530 nm. Preliminary results with a 10mg/L concentration of nanoparticles shows a difference that is not statistically significant when data is analyzed with a Mann-Whitney test. Experimentation will continue with an increased concentration of nanoparticles to see if the concentration of nanoparticles affects the oxygen saturation, increasing to 50 mg/L.


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The Identification of Optimal Viticulture Sites via the use of Geospatial Technology

Hannah Tarro

Geospatial technology is a field that, within 50 years, has transformed a variety of fields including viticulture which is the science, production, and study of grapes. Geospatial technology enables traditional farming methods to be replaced with more precise and efficient methods. The primary goal of this research was to identify optimal areas within the Appalachian region suitable for the development of wine grapes.

Research was conducted regarding what factors were the most influential in the development of grapes and to identify what the prime condition for each factor was. Using ArcGIS, data regarding a variety of variables that are crucial to the growth and development of wine grapes was collected including precipitation, frost, soil type, slope, and drainage. These variables were then geoprocessed in order to represent only their optimal conditions. The optimal conditions for each variable were selected and mapped in conjunction with the other variables in order to identify areas that met all the criteria conducive to the successful growth of grapes. It was determined that there is a significant amount of land in the Appalachian region, despite its showcasing optimal conditions for viticulture suitability, goes unused for this purpose. Further research would entail an application of the methods used to identify new suitable viticulture sites in Appalachia to other states, possibly suggesting that large amounts of United States land is either under or misused in regards to the wine industry.


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The Effect of Programming Languages on the Speed of the Solution of P and NP Problems

Jason Benn

There are many different programming languages used for a variety of different applications, but which language performs the fastest is still unclear. In order to test this, C, Java, Python, Ruby, and JavaScript programs were written to perform a Bubble Sort. Each program was written in a way in which the amount of time it takes to solve the problem was recorded in milliseconds. The independent variable was the language and the dependent variable was the solution time. The result is then outputted to a text document, and the execution is repeated 99,999 times. The programs were all run on a computer running Arch Linux, in order to have the smallest potential effect on the program as possible. Java's average solution time of 5.897 ms, followed by JavaScript with 8.626 ms, Ruby with 8.848 ms, C with 15.497 ms, and Python with 1222.713 ms. An ANOVA test was performed on the data resulting in a p value of 0, showing the data to be statistically significant. The alternative hypothesis for this experiment was that if all of these programs were written to perform the same task, then C would run the fastest. This is rejected, because Java was clearly the fastest, on average, out of all the languages. The language that the solution was written in definitely had an effect on the solution time. Some further research that could be done is testing other languages, and/or other problems.


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Gear Up: An App for Outdoor Enthusiasts

Samuel Dawson

Many students and workers struggle with planning and packing the right clothing or gear for their outdoor exercise excursions. Necessary gear is imperative for maintaining health, safety, and comfort. However, checking the constantly changing weather is not feasible for students or adults who already have very busy schedules. Instead, they choose their clothing and gear selection from the morning weather. Gear Up is currently being developed as a solution to this problem. This app imports real time data from an online API source, provided as a free service through Weather Underground, to give users reliable access to weather information. This app allows users to add and edit events, and then the app gets information from weather sites as it applies to the event, in the form of JSON files, to send them a notification about their event at a scheduled time. The users are able to manually set their preferences so that the notification recommends the optimal clothing and gear based on the forecasted temperatures and conditions at the time of their event. Additional features on currently being developed, which include saving data, adding an icon to the day on the calendar when an event is created, and improving the physical appearance and user-friendliness of the app.


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FreshFood - Tracking Food Usage to Reduce Waste

Vaishanavi Kundala

The purpose of this study is to reduce food wastage by creating an app that reminds and encourages customers to use items in their storage/fridge. According to a recent report by UNEP and the World Resources Institute (WRI), about one-third of all food produced worldwide, worth around US$1 trillion, wasted in food consumption systems. Food is the biggest contributor to landfill and a huge generator of greenhouse gases such as methane. Many families have food in the refrigerator and do not even know they have it or have forgotten about it and thus letting it rot and go to waste. Not knowing what is in the fridge can ultimately lead to food wastage. An app that finds recipes including ingredients in priority of their expiration date and sends reminders about expiration of food products can help reduce the food wastage in households. Adding food items into the app can be done by using receipt photo recognition, scanning of bar code (bar code photo recognition) or manually added. There will be two types of food for the sake of the app’s organization: groceries and pantry. Pantry food is any boxed or packaged food that does not need to be prepared. Since it does not require any preparation, reminders of the item’s expiration date can help keep it from being wasted. The app will help reduce the food wastage by coming up with recipes that include the ingredients of the food items closer to their expiration date.


I/We hereby certify that the above statements are correct and the information provided in the Abstract is the result of one year’s research. I/We also attest that the above properly reflects my/our own work (digitally signed).
A new synergistic Scatter/Transform Hybrid Cloak

Gadi Licht

Pictorial results showing improved cloaking are presented for different sizes. This project synergistically combines transform and scatter-cancellation cloaks to better cloak an object over more sizes and wavelengths. Ongoing data is being collected to support this claim. Transform cloaking is based on geometric transformations that bends a wave around the object. Scatter-cancellation cloaking relies on many small scatters placed around the object that cancels out the overall scattering fields that make an object detectable and only cloaks circular and sub-wavelength sized objects well. Transform cloaks theoretically cloak the best, but cannot cloak as wide a spectrum of waves and are harder to construct to the same ability as scatter-cancellation cloaks, which are less sensitive to approximations and imperfections.

Both cloaks have to be approximated with different materials at finite intervals, as the theoretically perfect cloak requires continuous parameter changes that cannot be constructed. To test the practicality of the new cloak, the experimenter only tested these approximations. The transform cloak part was done through a new method that maps “bridges” around the object using principles akin to holography. This should solve much of the transform cloak’s problems, as unlike the older transform model, this has no mathematical singularities and infinite values that cannot be made with materials. Additionally, the function changes slower making it a better approximated by the layered design. The scatter-cancellation part attempts to correct distortions arising from the layered approximation. Cloaks are made in Python and simulated in MEEP. Numerical analysis of results will be forthcoming.


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Crime is a problem that everyone agrees must be lowered drastically. There have been many advances in crime reduction, however, testing the Broken Window Theory using advanced analytics and implementing procedures based on those findings can bring about unseen changes. This research can be applied to cities all over the country to help police chiefs rations out their already low numbers of officers to areas that need the help most. I found out whether or not service requests could predict the instance of a serious crime and whether a specific type of service request had a higher affinity for a serious crime. I used Aster Express, an advanced analytics software, to find the types of service requests that were made in the 30 days leading to a serious crime and how closely linked those different types were to a serious crime, by creating a table with the downloaded data and running various algorithms on them.

This is one of the algorithms I will be using to conduct my research, which was developed by the man who made this blog post onto Aster Developer Exchange.

This is the other algorithm I will be using to conduct my research, which was also developed by a man posting on the Aster Developer Exchange, though it is a different one.

Aster Express Usage Tutorials:
https://www.youtube.com/playlist?list=PLbBFEEqZiHuuTcwGCmKz2JifBlmzmTDxC

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Applying Time-Bin Encoding to the Quantum Fourier Transform for Breaking Data Encryption

Siddharth Srivatsan

FBI Director James Comey noted that the Islamic State and other terrorist groups have increasingly turned to encrypted communications. Among these encryptions is RSA encryption, one of the most secure cryptosystems ever created, breakable only by using a quantum algorithm known as Shor’s Algorithm. At the heart of this algorithm is the quantum Fourier transform, a mathematical operation mapping wavefunctions in the time domain to the frequency domain in order to find the periodicity of the wavefunctions. Unfortunately, quantum decoherence and other problems have stifled past research. However, time-bin encoding, a method for encoding quantum states based on time-of-arrival, avoids many of the challenges other quantum computing systems face. In this research, photonic qubits encoded in the time-bin degree of freedom were theoretically evaluated for their ability to implement the quantum Fourier transform. An algorithm for performing the quantum Fourier transform was created using code in MATLAB, and with this, control trials for the quantum Fourier transform of 1 through 32 qubits were calculated. Then, a scheme for the two-photon quantum Fourier transform using time-bin encoding with optical elements was constructed. With this, sources of error, specifically those related to mode mismatching and photon loss, were identified and modeled. Progress up to this point has been made. These will then be incorporated into the quantum Fourier transform code, and the fidelity of the process will be evaluated. Research is still presently ongoing.


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