Understanding how goldfish learn and remember a task using spatial cognition is integral to characterizing the evolutionary development of higher brain function. Being able to rewrite biology textbooks to reflect the importance of spatial cognition in fish as the first group on the vertebrate branch from which mammals descended would be an exciting undertaking. To this end, I studied (1) the long-term memory span of goldfish and (2) how goldfish learn during training. My research showed that goldfish (1) have a memory of at least four months and (2) use turn memory during the first week of training to find food in a maze, switching to spatial memory by the end of four weeks. Forty goldfish were trained daily to turn left into the cubicle containing food in a clear maze. The control group was trained in a white maze surrounded by a box to eliminate allocentric (extra-maze) and egocentric (intra-maze) cues. The other fish were tested every four days during the training period in three different mazes rotated 180° without food and were observed turning left or right. If the fish turned right, despite having turned left earlier in the day, then the fish used place strategy or spatial memory to navigate to the same spot as the food had been earlier using allocentric cues. The number of fish using turn strategy decreased from 16 on day 3 to 10 on day 27, and the number of fish using place strategy increased from 6 to 13, which was statistically significant at p < 0.05. In summary, goldfish are keen observers of their environment, retaining the layout of landmarks for several months and suggesting the presence of a cognitive map.

**Bibliography**


CD47 is a ubiquitously expressed cell surface receptor for thrombospondin-1 and the counter-receptor for signal-regulatory protein-α (SIRPα). High expression of CD47 on several types of cancer cells has been identified as a ‘don’t eat me signal’ that inhibits their killing by macrophages or NK cells. Conversely, the CD47 antibody B6H12 that blocks SIRPα; binding enhances macrophage-dependent clearance of tumors in several mouse models, although others have shown that such clearance can be independent of SIRPα; signaling. Stem cells also play an important role in the pathogenesis of cancer. Cancer stem cells have been reported to express elevated CD47 levels, but the role of CD47 in cancer stem cell function has not been examined. Breast cancer stem cells (bCSCs) isolated from the Triple Negative MDA-MB-231 cell line have up-regulation of cancer stem cell markers as compared to differentiated MDA-MB-231 cells. Global analysis of gene expression of bCSCs treated with B6H12 antibody showed up-regulation of tumor suppressor genes (TXNIP, LOX and PLS3), the RNAi silencing gene DICER 1, and TOP1, but decreased expression of EGFR. We further found that CD47 and EGFR are co-localized and interact with each other in MDA-MB-231 breast cancer cells, however the treatment with the CD47-blocking antibody, B6H12, disrupted the interaction between CD47 and EGFR. Treatment with B6H12 antibody inhibits EGF induced EGFR-tyrosine phosphorylation and cell proliferation. We observed that B6H12 specifically targets bCSCs but not differentiated cancer cells, and this CD47 signaling is independent of SIRPα; Our study shows how the CD47 blocking antibody can target breast cancer stem cells by down-regulating cell surface expression of EGFR via enhancing K63 ubiquitination or by releasing exosomes. This novel mechanism makes CD47 blocking antibody an attractive therapeutic candidate for treatments of Triple Negative breast cancer stem cells.

Bibliography
Over the years, many societies have been losing their historical knowledge of effective food preservation techniques because of modern technology and abundance. In the absence of electricity for refrigeration, few people would have a plan for keeping food from spoilage. Of the important food groups, animal protein in particular is easily perishable. In this experiment, I will be exploring the various common methods of meat preservation and measuring their effectiveness for long-term preservation.

Different cultural traditions have used various means to discourage growth of bacteria and mold in freshly purchased meat. This investigation *** WILL NOT *** involve measuring actual spoilage since this will be left to a follow-on project next year so no SRC review should be needed since no harmful chemicals or biological substances will be present.

We will take one key property of prepared food, moisture content, to compare the degree that each preparation technique tested reduces the water content of the samples. Available water in meat products is known to directly encourage or limit growth of microorganisms as a hospitable or hostile environment and effective ranges are documented. Since we not actually permitting the samples to age, this is a food chemistry rather than a microbiology experiment.

A 1,134 g (2.5 lb.) base sample of meat will be divided into five 226.8 g (1/2 lb.) case samples and prepared using three historical preservation techniques – (1) low temperature smoking using an indirect source wood smoker, (2) High temperature grilling using direct wood charcoal, (3) salting with natural sodium chloride plus one modern method – (3) pan cooking and (5) an unprocessed control.

After preparation, the water content of three subsamples of each sample will be estimated using a moisture analysis described in the UN Food and Agriculture Organization (FAO) Simple Test Method for Meat Products. Method summary:

1. Chop the sample in a food processor.
2. Dry smaller subsamples in weighed beakers and filter paper in microwave using estimated heating times documented in method for sample size.
3. Cool the subsamples in a silica gel desiccator and accurately weigh the beaker plus dried samples plus filter paper.
4. Repeat drying until constant weight is obtained.
5. Determine the water content using the %moisture formula (%M = original container + sample weight before drying) / container + sample (after) drying x 100)

Once the moisture content is determined for samples in each category,
compare the relative effectiveness of water reduction for each historical technique with a modern technique and the control. Analyze which methods would best preserve the samples using documented moisture levels associated with spoilage.

**Bibliography**

In 2013, over 450,000 Americans died from Alzheimer's disease. Early diagnosis may play a key role in increasing the efficacy of potential treatments, thus we are developing a new diagnostic tool for Alzheimer's. Tau, a highly-soluble intra-cellular protein which promotes the proper formation of microtubules, contributes to disease pathology. We hypothesize that if luminescent proteins can be fused to tau, through the process of protein-fragment complementation, a more useful diagnostic tool can be created. Protein fragment complementation is a process by which a luciferase molecule is divided into C and N termini; each terminus is attached to a protein, and upon aggregation of this protein, a detectable light signal is emitted. Using a cell based approach, we have accumulated evidence that luminescent constructs can be attached to the tau protein, and give off a detectable light signal. We have also demonstrated that upon addition of extracellular tau fibrils, this signal increased considerably.

This data serves as proof of principle for further experimentation, as our plan is to test our assay using cerebral-spinal fluid and blood samples from Alzheimer's patients and a control population. This information is very important because it is a substantial step toward the development of a more efficacious diagnostic tool for not only Alzheimer's disease, but other diseases in which tau levels rise including traumatic brain injury (one of the leading causes of death and disability in children and young adults).

More recent developments in this diagnostic test include techniques such as modulation and astronomical imaging. In order to increase the sensitivity of our assay so that accurate and early detection can be made, new methods of detecting very small levels of light have been experimented with and developed. Photon detectors used in telescopic devices are being explored for application to microscopic assays such as this one.

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Principles of Neural Science, 5th editionNeuroscience, Exploring the Brain
DOES THE CELLULAR UPTAKE OF GOLD NANOPARTICLES HAVE A CORRELATION WITH THE PH

Abstract

The purpose of my experiment is to help further research in the field of nanotechnology. If nanoparticles are put in an ideal PH best suited for absorption by the cells, we can increase their efficiency and therefore reduce the amount of toxicity left in the body as well. My experiment consisted of four parts. First part is the synthesis of nanoparticles, second part is testing the absorption of nanoparticles, third part is finding the correlation between pH and nanoparticle absorption by the carcinogenic cells, fourth part is observing structural changes. I did few trails to find out the optimal ratio of blood to colloidal solution. I tested 6 different specific pH’s within the physiological range 6-8.5. Certain pH’s were favorable to the cellular uptake of nanoparticles. In certain pH’s I saw 2-5 nanoparticles being engulfed by the cell and in other pH’s I saw than less than 2 and others I saw no cellular absorption. My results coincided with my hypothesis; however there are aspects of my project that can be of future interest. My hypothesis is well supported because I have seen the fluctuations in the pH effect the cellular uptake of nanoparticles. I have also noticed the response of the cells alone to the variant pH gradient. The favorable response of the cells moving towards the pH 7 and away from pH 6 and 8 also supports my hypothesis that the cells are responding to the variant PH.

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Amir Tabrizi1, Fatma Ayhan2, Hakan Ayhan2*
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Bioengineering Division, Ankara, Turkey.

7) Applications of gold nanoparticles in cancer
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1Departments of Radiology and Medical Physics, School of Medicine and
Public Health,
University of Wisconsin – Madison, Madison, Wisconsin, USA;
2University of Wisconsin Paul P. Carbone Comprehensive Cancer
Center, Madison, Wisconsin, USA; 3TycoElectronics Corporation, 306
Constitution Drive, Menlo Park, California, USA

8) Spontaneous ordering of Biomodel ensembles of nanoscopic Gold
clusters by C.J Kiely, J.Fink, M.Brust, D.Bethell, and D.J Shiffrin

9) Neutrophil Mediated Phagocytosis of Staphylococcus aureus by Kok P.M
van Kessel, Jovanka Bestebroer, and Jos A.G van Strijp
The role of the central auditory structures such as the Dorsal Cochlear Nucleus (DCN) in the pathophysiology of tinnitus is well established. While blast-induced tinnitus has become one of the co-morbidities in the spectrum of blast induced neurotrauma, studies related to glial reactivity in these central auditory structures and their implication following the blast are extremely limited. Adult male Sprague Dawley rats were subjected to a single blast overpressure of 22 psi by a custom built shock tube, and they were separated into two groups: sham and blast. In each of the groups, the rats were allowed to survive for either 1 day, 1 month or 3 months. Following the conclusion of neurophysiological recording from auditory centers, brains were harvested, sectioned, and processed for astrocytic reactivity. Astrocytes were identified by glial fibrillary acidic protein (GFAP) immunoreactivity and the tissues were placed on microscope slides for quantification. After scanning the microscope slides, the DCN was partitioned into three approximately equal tonotopic sections, and astrocytes were counted from each of the three sections. Blast exposed rats showed significantly higher level of astrocytes compared to sham with their numbers reaching a peak at 1 month after the blast. Astrocytic proliferation in DCN was elevated at all time points, in which the superior DCN tonotopic sections had the most astrocytic proliferation. Taken together, the findings suggest that a single blast exposure results in sustained astrogial changes that may contribute to or extend reactive changes in auditory centers after severe brain damage. These findings also provide vital information to the specific location of the astrocytic proliferation for targeted therapy.

Bibliography
Zingiberaceae are an order of tropical plants, commonly known as banana and ginger plants. The order comprises over 2500 species grouped into eight families. While floral characters have been used to characterize families, seed anatomy has been underutilized. Among observed seeds, one potentially significant character is the operculum. The operculum is an interesting small cap-like structure crowning the embryo of a seed. Very little research had been done before on opercula, so the purpose of this project was to test if families in Zingiberales have unique operculum shapes and if opercula can be used to identify a seed’s family.

The methods of this experiment consisted of digitally reconstructing an operculum, and analyzing that shape using geometric morphometrics. To reconstruct the opercula, I used the computer program Avizo to compile synchrotron radiation X-ray tomographic microscopy data into a three-dimensional representation of the opercula. Using this structure, images were created representing the cap-like shape and geometric morphometrics, a technique to mathematically analyze and compare shapes, was performed for 60 opercula. This was done through a computer program launched in Mathematica. The result was a coordinate graph with axes representing variance in certain parts of the opercula (height, length, etc.).

The final results concluded that different families portray different opercula shapes. The opercula within a family clustered together reasonably well, indicating that operculum of the same family had the same type of shape. However, the clusters of families had some overlap meaning families do not necessarily have distinct shapes from each other. Therefore, while the families typically have similar operculum shape, operculum is not a reliable character for classification.

**Bibliography**

Zingiberaceae:

Synchrotron & Figure G:
Cucumbers are an important vegetable crop and an important source of income for farmers of Michigan. The oomycete pathogen Phytophthora capsici causes fruit rot in cucumbers and a wide variety of other vegetables. Previous research in this lab found that certain cucumber cultivars demonstrated increasing resistance to P. capsici after their stage of rapid elongation, transitioning at 10–12 days post-pollination (dpp). This increase of resistance with age is called age-related resistance (ARR). Studies showed that the fruit peel is associated with ARR. Reports from other laboratories indicate that cucumbers are capable of producing methanol-soluble antimicrobial compounds. In this work, bioassays were conducted to evaluate the effect of aqueous and methanolic extracts of cucumber fruit peel on pathogen growth and to test for a difference in effects of varying ages and genotypes of cucumber. Vlaspik (ARR +) 8-dpp (pre-ARR) and 16-dpp (post-ARR) and Gy14 (ARR -) 16-dpp cucumbers were peeled, peel was sequentially extracted twice each with water and methanol, and extracts were lyophilized. OP97, NY 0664-1, NY 0664-1 RA (red fluorescence), and NY 0664-1 GA (green fluorescence) isolates were used to prepare inoculum with a concentration of $10^5$ zoospores/mL. Inoculum and extracts redissolved in water or 10% methanol at 25 μg/μL were added to a 96-well plate filled with V8 media. Methanolic extracts inhibited the growth of P. capsici, but aqueous extracts had a stimulatory or no effect. Differences in age and genetic capacity for ARR did not produce observable differences in P. capsici growth.


Bibliography
Water Inside Fruits

Abstract

It is commonly thought by the general population that all living plants are 70% water. The purpose of this investigation is to determine the percentage of water that is in fruits and to see which fruit will lose the most water using a dehydrator. The researcher will test 5 different fruits, oranges, watermelon, apples, strawberries and grapefruit. Each fruit will be sliced then the fruits will be weighed using a balance scale (grams) before being placed in a dehydrator for a period of 48-72 hours. After the dehydration period the samples will be weighed again to calculate the amount of water loss. Fruit is a source of many different vitamins which are important to well-being. The hypothesis is that oranges contain the most water. The experiment is currently ongoing and data for comparisons is still being collected.

Bibliography

The purpose of this investigation is to compare the growth of radish plants in the following plant media: Miracle Grow Potting Soil, 50% Perlite & 50% Peat Moss, Top Soil, Rock Wool/ hydroponic solution, Crystal Soil and a miniature fiber grow pellet Green House. The researcher’s hypothesis is that the plants that are grown in Fiber Grow Green House will grow taller than the plants grown in Top Soil, Potting Soil, Rock Wool, Crystal soil and the Perlite & Peat Moss mix. This is because the Green House has enough nutrients that the plants need in order to grow. Rock Wool provides a buffering reservoir of nutrient solution in the root zone. There will be 2 seeds planted ¼ inch in all 6 mediums and will be observed and data recorded by the researcher. The controls in this investigation are the radish plants in the soils and the amount of water and sunlight each plant receives. The researcher will make daily observations on the plant growth over a period of 3 to 4 weeks.
Identifying a New Apolipoprotein-B-100 T-Cell Epitope in the Exacerbation of Atherosclerosis:

Atherosclerosis is the buildup of plaques in an organism's arteries, this disease leads to other forms of cardiovascular disease which collectively are the number 1 killers in the United States. It was previously found that these plaques consist of a significant amount of T-cells which increased plaque size greatly, this project aimed to identify the specific peptide(s) from ApoB-100 that triggered this T-cell response; possible peptides were Peptides 3, 4, 6, 7, 9, and 31. The overall objective of this experiment was to test if the peptides listed previously induced an immune response and to test if they were atherogenic with three different approaches. I hypothesized that peptides 3, 6, and 31 would be immunogenic and that peptides 3 and 6 would be atherogenic. In the immunogenicity test, the peptides were injected into an ApoE-/- subject near the lymph nodes, these lymph nodes were later isolated and the T-cells were tested for proliferation when exposed to the peptide in vitro; this same process was used for finding if a peptide-specific culture of T-cell clones would react to peptide exposure. The results indicated that P3, P6, and P31 were immunogenic. For testing if the peptides were atherogenic, peptides 3 and 6 were injected into an ApoE-/- subject near the lymph nodes and the aorta was isolated ten days later. An analysis of the aorta for plaque coverage indicated that P6 was atherogenic. P6-specific T-cells and T-cell clones also tested positive for atherogenicity post tail vein injection. Overall, this project identified immunogenic peptides, an exacerbator of atherosclerosis, and developed a P6 specific T-cell-clone line to track disease progression.

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independent risk factor for accelerated progression of sub-clinical
Heart disease is a leading cause of death globally. Loss of healthy heart cells due to heart disease is irreversible. Heart transplantation is an established way of saving heart patients, but there is a critical shortage of heart donors. About 50,000 people need heart transplantation worldwide, but only about 5,000 transplants occur each year. Also, the established transplantation technique has donor compatibility issues. Recent advances in direct reprogramming, such as converting one cell type to another, provide a promising therapeutic regime that could lead to a new heart regeneration therapy. My experiment aimed to identify transcription factors effective in regenerating heart cells using the direct reprogramming technique. Direct reprogramming would eliminate the need for a donor heart and the related donor-compatibility issues. I researched twelve transcription factors that are found in heart cells. I analyzed the data available for FAC1, FOXJ2, GATA4, MAF, MEF2A, NKX2.5, OCT1, POU3F2, RSRFC4, SPF, SRF, and ZIC3 using the website http://amazonia.transcriptome.eu. The cell types that expressed the same, or higher, levels of a given transcription factor were selected for further analysis. If there were more than five different cell types that highly express the transcription factor, then that the transcription factor was considered to be not specific enough for heart cells and was discarded. Since it was a cumbersome process to analyze the data manually, I wrote a program in Microsoft Visual Basic for Applications 7.0 using Microsoft Excel 2010 to analyze the data. I found that 5 transcription factors: NKX2.5, RSRFC4, SRF, MEF2A, GATA4 would be effective in reprogramming adult human cells to heart cells. I also found that B cells (Lymphocytes) would serve as good starting cells to be reprogrammed to heart cells as they already contain RSRFC4 and MEF2A. This automated process to identify the valid transcription factors can be utilized for other organs. Such processes are required to effectively and quickly analyze the massive quantities of data available in microarray databases and contribute to the success of regenerative medicine.
Ebola Epidemic in West Africa: A Transmission Model to Compare Interventions

Purpose: a) Design and implement a gravity spatial model for the ongoing epidemic of Ebola Virus Disease (EVD) in West Africa; and b) use this model, to evaluate the number of cases eliminated by different types and levels of intervention, such as quarantine, lock-downs, and border closure, aimed at reducing local or long-range transmission of EVD.

Methods: The gravity spatial model was fitted to data from May 24 to September 30, 2014, and simulated to October 31. The model provided data about the balance of transmission from local and long-range sources. The model was used to simulate different levels and types of interventions and compare the efficacy of interventions by examining the case reductions of each one.

Results: This gravity model accurately fits the data from the epidemic and accurately forecasts cases and deaths for the month after the data. The model's spatial spread component allows it to explain the transmission dynamics of the EVD outbreak in West Africa, including multiple "ignition" cycles of the outbreak in Guinea. The intervention analysis indicates that local transmission reductions such as more effective quarantine in Liberia, and long-range transmission reductions such as border closure in Sierra Leone, were the most effective interventions.

Conclusion: The gravity spatial model is an effective framework for understanding transmission dynamics in the EVD epidemic in West Africa. It successfully fits and forecasts data from the outbreak. Therefore, the intervention analysis presented here can help to guide

Bibliography

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Introduction: The Ancient Egyptians used leeches for bloodletting thousands of years ago because they believed that blood had to be filtered in order to maintain proper health. The use of medicinal leeches, Hirudo medicinalis, has made a comeback in medicine and is now approved by the FDA. They are used in reconstructive surgeries and finger reattachment. Hirudotherapy, or leech therapy, is also believed to be a treatment option for several diseases including arthritis, endometriosis, glaucoma, cardiovascular and vascular problems, hearing problems, alopecia, and more. This experiment tests a factor of leech therapy that has not yet been explored. Which component of the blood will leeches ingest, blood plasma or formed elements?

Hypothesis: Leeches store food up to several times their body weight. The hypothesis of this experiment proposes that leeches fed with whole bovine blood, leeches fed with blood plasma, and leeches fed with resuspended formed elements will have statistically significantly different percent increases in mass after they have fed on the different blood components.

Procedure: Separate whole bovine blood into plasma and formed elements with centrifuge. Resuspend the formed elements in saline solution. Fill test tubes with whole blood, test tubes with plasma, and test tubes with resuspended formed elements. Take mass of leeches. Secure a section of pig intestine over the test tube openings and allow the leeches to attach onto them and feed on the various foods in the test tubes. When they are done feeding and detach from the apparatus, take the mass of the leeches. Calculate percent increase in mass of leeches before and after feeding. Compare the results of the leeches that fed on whole blood, blood plasma, and resuspended formed elements.

Results: There is a noticeable correlation between the variables tested and the average percent increase in mass of the leeches that fed on them. The average percent increase in mass of leeches fed with whole bovine blood was 527%. Leeches fed with plasma increased by an average of 368%, and leeches that fed on resuspended formed elements increased by 63%. However, the ANOVA test showed that the three groups did not have statistical significance, and neither did the t-tests between the control group and the remaining two groups.

Conclusion: The hypothesis was not supported according to statistical ANOVA and t-tests.

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This study evaluates frequency analysis of breath sounds in detecting early lung changes due to air pollutants in individuals with normal spirometry.

Frequency patterns of recorded breath sounds were studied in 10 asymptomatic never-smokers and 11 age-matched, asymptomatic firefighters. Right and left lung sounds were recorded separately to analyze regional differences. The relationship between sound frequencies and their relative amplitudes (energy) was explored. Statistical analysis was performed using a Student t-test.

Frequency peaks with amplitude values between 50 and 100% of the tallest peak (high energy peaks, HEP) were analyzed. Never-smokers and firefighters with normal spirometry were compared for their average maximum HEP. Firefighters had a significantly greater maximum HEP (p-value = 0.04).

<table>
<thead>
<tr>
<th>Groups</th>
<th>Average Maximum HEP (Hz)</th>
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<tbody>
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<tr>
<td>Firefighters</td>
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The difference in the maximum frequencies between the left and right lung were calculated to assess variability between the two sides. Significantly greater differences were noted between left and right lung maximum frequencies in firefighters compared to never-smokers (p-value = 0.036).

<table>
<thead>
<tr>
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<tr>
<td>Firefighters</td>
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</tbody>
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This study finds:
1. The presence of greater regional differences between the right and left lungs
2. Greater maximum HEP
In individuals exposed to air pollutants and with a normal spirometry test. These findings may indicate the presence of early lung injury in asymptomatic, vulnerable individuals.

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Hypertrophic Cardiomyopathy (HCM) is a genetic condition that results in excessive thickening of the heart muscle and increases the risk of Sudden Cardiac Death. This study evaluates the reliability of heart sounds frequency analysis in distinguishing HCM from conditions that thicken the heart muscle (Hypertension, HTN). In addition, this study compares the frequency analysis method to electrocardiogram (EKG) testing for identifying HCM.

Widening of the frequency range of heart sounds upon standing identified the majority of subjects with HCM. 88.9% of HCM subjects showed an increase in the range of frequencies from lying down to standing (average change = + 57.74 Hz). In comparison, 88.9% of normal subjects displayed a significant decrease in the range of frequencies (average change = - 27.2 Hz, p-value = 0.01). 88.9% of subjects with HTN also showed a significant decrease in the range of frequencies upon standing (average change = - 38.62 Hz, p-value = 0.008). Frequency analysis was unable to differentiate Normals from the HTN group (p-value = 0.64).

The EKG test had a high true negative rate of 100% but its ability to detect HCM was low (38.9%). Its false negative rate was very high at 61.1% implying that it was unable to identify the majority of HCM subjects. The Heart Sound Frequency Test had a high true positive and true negative rate in this study (88.9% each) and appears to have the characteristics of an ideal screening test.

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The notion that antioxidants can help fight cancer is popular. However, the mechanism(s) for the effect of antioxidants in cancer is unclear. In addition, clinical trials have reported inconsistent reports. The goal of this project is to study the effect of antioxidant supplements on the ROS system in cancers. The study was conducted in two parts: In vitro analysis on the effect of antioxidant supplements in human established cell lines and a computational analysis on the effect of antioxidants (Vitamin E and n-acetyl cysteine) using RNA-Seq data from a mouse model of human lung cancer. Four main antioxidant enzymes were studied: sodium dismutase (SOD), glutathione peroxidase (GPX), and catalase (CAT). The in vitro analysis showed that breast and lung cancer cells grown in medium containing antioxidant supplements such as Vitamin C, Vitamin E, and green tea extract and n-acetyl cysteine for 48 hours had decreased antioxidant enzyme activity compared to cancer cells in medium without supplements. The bioinformatic analysis showed that exonic mRNA expression of SOD decreased with treatment which correlated with the results from the in-vitro study. The mRNA expression levels of CAT and GPX did not show any significant change with the antioxidant treatments in the animal models. However, the treatment with antioxidant significantly changed the expression of many other intronic RNAs of genes. Enrichment analysis showed that these differentially expressed genes are involved in cancer, lipid metabolism, and membrane transport pathways.
Analysis of the Effects of Induction of Exogenous p16 on Immortal Human Tissue

The title of this project is “Analysis of the Effects of Induction of Exogenous p16 on Immortal Human Tissue Cultures.” The purpose of this experiment is to determine whether or not the naked mole rat p16 gene will work in human cells to stop cancer growth. The naked mole rat is of interest because of its resistance to cancer. Cancer has never been observed in them. The p16 gene prevents cell division once individual cells come into contact. The p16 gene is the reason that naked mole rats do not get cancer. The following hypothesis will be explored: If the number of cells stays steady as time goes on, then p16 is capable of arresting human cell growth. If the number of cells does not remain steady as time goes on, then p16 is not capable of arresting human cell growth. The hypothesis is that the NMR p16 gene will work in human cells to stop cancer growth since NMR p16 and human p16 proteins are highly similar (NMR genome project, Natma, 2011). The results were inconclusive and the experimentation has not yet been completed. There has been some difficulty growing the 293T cells and the MCF10A cells. There also has been some difficulty transfecting the MCF10A cells. So far, there has not been a high enough production due to expired x-fect, and low DNA concentration. The expected outcome is that the naked mole rat p16 gene will work in human cells to stop cancer growth. If the naked mole rat p16 gene works in human cells to stop cancer growth, the hypothesis will be supported.

Chow, D. (2013, June 19). Immune to Cancer: Naked Mole Rats Reveal
Multiple Sclerosis (MS) is a debilitating disease that slowly causes a patient to lose motor and intellectual functionality. The disease causes the body’s leukocytes to attack the myelin on axons, and thus kill the neurons of the brain. These neurons in the brain are thought to be normally replenished by the pericyte, a pluripotent stem cell that rests on blood vessels throughout the body; however, in MS the rate of neuronal death greatly exceeds the rate of neuronal formation. Past research has shown that the pericyte helps alleviate MS during hypoxia (low oxygen conditions) in mice in which MS has been induced. The pathway by which this occurs has not yet been established, though micro RNA (miRNA) may be involved. Of the miRNAs that have been shown to be overexpressed in the hypoxic pericyte, Let-7d stood out as it has been shown to be involved in the differentiation of neuronal precursors by the suppression of the protein TLX and the resulting induction of miRNA 9. Increased differentiation of the pericyte into neurons would replenish the neuronal supply lost due to MS.

Thus, the hypothesis presented is that in hypoxic conditions, overexpression of let-7d leads to differentiation of the pericyte into neurons, alleviating MS. To address this hypothesis, primary pericytes were exposed to hypoxia for 0, 24, and 48 hours. Then, proliferation levels of the pericyte were quantified by the use of a microscope, Let-7d, TLX, and miR-9 expression levels were quantified by qRT-PCR, and immunohistochemistry was used to look at neuronal differentiation by the use of neuronal markers for Nestin and Neurofilament.

Many drugs that target MS cannot cross the Blood Brain Barrier for the pericyte takes in these drugs and then distributes them back into the blood stream. It is easier to target pericytes than neurons, so possibly this research could lead to the development of a drug that helps to better alleviate MS in patients.

Purpose: To determine how the action of invertase contributes to the amount of glucose that we absorb from different foods.

Hypothesis: If different foods are tested for the amount of glucose they have before and after breaking down the sucrose in the foods, then the foods that do not taste as sweet would have the lowest total glucose load, because they have a small amount of glucose (before converting the sucrose) and a small amount of sucrose that would be converted into glucose.

Procedure:
1. The Diastix glucose test strips were tested to see if they were working by dipping one strip into each cup of a glucose dilution series that had eight cups labeled 4%, 2%, 1%, 0.5%, 0.25%, 0.125%, and 0.0625%, and 0%.
2. The activity of the invertase was checked to see how long each food should be tested by putting 0.5 mL of invertase into 15 mL of a 10% sucrose solution, taking glucose concentration readings every 5 minutes for the first 30 minutes and every 10 minutes for the next 60 minutes, and finding the time when the invertase stopped converting sucrose into glucose (which is when the glucose concentration remained the same for three readings). The time when the invertase stopped converting sucrose was called the “linear time point.”
3. The foods that were tested include: maple syrup, milk, Lipton green tea, bananas, Jif peanut butter, honey, apple juice, Hidden Valley Ranch salad dressing, orange juice, coke, and diet coke.
4. The glucose concentration of the foods was tested before and after adding invertase by labeling 33 cups with their respective food and trial number (three trials per food), taking a glucose reading of each food before adding invertase, diluting viscous foods into 10% solutions, adding 0.5 mL of invertase to 15 mL of each food, and taking a glucose reading of each food at the predetermined linear time point. A bar graph including both glucose readings was created for each food tested.

Results:
The foods that had the least amount of glucose after converting the sucrose to glucose were milk, green tea, and diet coke at 0%. In second place was orange juice with a 1% glucose concentration, followed by apple juice and coke at 2%, and salad dressing at 10%. Maple syrup, peanut butter, bananas, and honey all had the highest glucose concentrations at greater than 20%.

Bibliography
Scientific Problem:
More than 90% of breast cancer mortalities are attributed to cancer metastasis and chemotherapy resistance, for which the underlying mechanisms remain unclear. In recent years, accumulating evidence suggests that cancer stem cells contribute to metastasis and chemo-resistance. Meanwhile, several receptor tyrosine kinases (RTKs), well-known cell signaling mediators in human cells, were found to be involved in breast cancer progression and metastasis. This project will investigate specific RTKs to see if they play a critical role in breast cancer stem cells.

Hypothesis:
Specific RTKs may contribute to the characteristics of breast cancer stem cells. These RTKs can act as tumor markers or therapeutic targets for breast cancer.

Methods:
Mammosphere formation and FACS assays were used to confirm stem cell characteristics of stable cells overexpressing the transcription factor Snail1. A Q-RT-PCR was performed to determine the expression levels of all known RTKs in this stem cell model. Several Q-RT-PCR and western blot experiments were further performed to detect the relative expression of DDR2 in both human and mouse breast cancer cell lines.

Results:
1. Snail-overexpressing cells showed apparent epithelial to mesenchymal transition (EMT).
2. Snail overexpression led to a significant increase in CD44high/CD24low stem cell population and mammosphere formation.
3. Out of all the RTKs, DDR2 had the highest expression level in snail-induced stem cells.
4. The expression of DDR2 was highest in Basal B human breast cancer cell lines, which is the breast cancer subtype associated with the stem cell/progenitor cell.
5. The expression of DDR2 was significantly high in metastatic 4T1 mouse tumor model.

Conclusions:
DDR2 was shown to be highly expressed in stem cell models and metastatic cells. Thus, DDR2 is a potential critical molecule in cancer stem cells, which contributes to breast cancer metastasis and chemo-resistance.

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Many bacteria grow in households. One of the most common bacteria in households is E.Coli. Although there are antibacterial products that claim they kill most of the bacteria in households, how fast do they kill it? Many people buy antibacterial products without really knowing the specifics about the product. The product may not kill all types of bacteria and may take longer than expected. The purpose of this project is to figure out what effect certain antibacterial products have on E.coli DH5alpha and how fast they can kill it. E.Coli DH5alpha is a safer form of E.Coli. It’s bio safety level 1, considered lab-safe, and Risk Group 1. Safety precautions will be taken to ensure nothing happens to anyone. There will be four different soaps that are tested, each with 15 trials. The agar will be grown, following a certain procedure then the bacteria will be grown on it. The bacteria will grow overnight and it will be tested the next day. The control group will be a regular household cleaning product, such as regular soap, that doesn't kill bacteria. The other three groups will be the experimental groups. Each experimental group will be tested with a different antibacterial product that will be left on for a certain amount of time. The time it takes to kill the bacteria and the colonies of bacteria will be recorded in a data table. The independent variable is the antibacterial product. The dependent variables are the effectiveness of the product and time. The hypothesis to be tested is: if Type B antibacterial product is used then it will work better and kill the bacteria faster.
Free radicals and oxidants have recently come into public view and many people take antioxidant supplements in order to counter negative effects on the body. In this experiment the effectiveness of different antioxidants at countering the effects of an oxidant in daphnia magna was measured. In order to do this daphnia were put into a hydrogen peroxide solution, which lowered their heart rate, and then into an antioxidant solution, which helped return the heart rate to normal. The results showed that the zinc and selenium solutions were the most effective at returning the heart rates to rest because the differences between the final and initial heart rates were not significant and the rate of increase was the highest. Spring water and turmeric were least effective and had significant differences between final and initial heart rates. Vitamin C fell in the middle with no significant difference it and the heart rates for selenium/zinc or turmeric. The findings were that the solutions were all effective at countering the effects of hydrogen peroxide in daphnia however only zinc, selenium, and vitamin C were successful in returning the heart rate to resting.

Bibliography

I wanted to find out the effect of nanoparticles on the growth of E. Coli. I set up an experiment. First, I measured the optical densities of the bacteria and the nanoparticles, separate and mixed, at different dilutions. I used a spectrophotometer, which I set at a 600 wavelength and used a broth as a media. I then set these samples overnight to allow the bacteria to grow. When I took them out and measured the optical density again, it was too high for the machine to read. Therefore, I further diluted the samples and measured the optical densities again. My results showed me that the amount of bacteria actually decreased overnight. From my results, I was able to conclude that nanoparticles slow the growth of E. Coli. Also, the more nanoparticles are present, the more the growth of E. Coli. was affected. To receive accurate results, I would need to perform the experiment multiple times, and then look for an evident trend. If I were to experiment again, I would definitely use bigger sample sizes, and maybe even further my research and try to propose a way to separate the bacteria and the nanoparticles to see how much of the nanoparticles the bacteria absorbed, or if any was absorbed at all. I would also like to see the effect of nanoparticles on cancerous cells.
Category **MI**  
**L25**  
Silver Nanoparticles Vs. A Pharmaceutic In Killing E. coli

**Abstract**

This experiment was done to test the effectiveness of silver nanoparticles vs. penicillin on E. coli. This will show if silver nanoparticles can be used as an alternative antibiotic, to prevent the negative effects of overusing one type of antibiotic. It was hypothesized that penicillin would be more effective than silver nanoparticles in killing E. coli. In this experiment, E. coli was streaked onto nutrient agar plates. Then, coffee filter discs were soaked in different concentrations of silver, which was created by a serial dilution. After that, three discs, soaked in the same concentration of silver, were placed into a petri dish. This was done for discs from every concentration of silver. Also, three discs of penicillin were placed in one petri dish. Each disc represented one trial, and the discs were placed a certain distance apart so they would not interfere with each other.

All of the petri dishes were incubated for at least 24 hours, and after 24 hours, the diameter of the ring around each disc was measured. This was the zone of inhibition. After recording the results, the hypothesis was found to be not supported. The penicillin trials all had no ring of inhibition around the discs. This showed that penicillin was not at all effective against E. coli. The highest concentration of silver nanoparticles was more effective than any other concentration of silver nanoparticles. This shows that silver nanoparticles are a good substitute for penicillin against some bacteria, but that they do not provide an alternative to prevent overuse of an antibiotic.

**Bibliography**


Abstract

The purpose of this experiment is to determine the mitochondrial DNA (mtDNA) haplotype of Homo sapiens in order to classify the sequence into one of thirty-six haplogroups. The hypothesis was that if the mtDNA sequence of the isolated DNA sample is determined, then the mtDNA sequence mutations could be used to determine the haplotype sequences. Haplotypes are mtDNA sequences that one inherits from their mother. The haplogroup is characteristic of the matrilineal most recent common ancestor. Mutations are accumulated in mtDNA and passed down through generations. Haplogroups are determined based upon the mutations accumulated in the mtDNA. Mitochondrial DNA was isolated from participants' saliva, the mtDNA HyperVariable Region II was amplified using Polymerase Chain Reaction, column purified, and sequenced. This sequenced mtDNA data allowed for the identification of mutations in HyperVariable Region II. These mutations were then compared to the revised Cambridge reference sequence in order to determine the haplogroup.

In this experiment, 12 individuals' haplogroups were determined based on their mtDNA haplotype. The hypothesis was supported. It was found that it is possible to determine haplogroups by looking at the mutations in haplotype mtDNA sequences. Five different haplogroups were identified: K, U, B, H, and D. Over 50% of participants belonged to European haplogroups, either K or U. This experiment can be applied to genetic research in the field of inheritable diseases. With the haplotype origins identified based on geographical ancestry, protein mutation and disease susceptibility can be determined in certain groups of people.

Bibliography


The purpose of my science fair project was to test the effect of green and black tea on Baker's Yeast. Yeast cells and cancer cells share a gene that targets certain drugs by repelling them. Researchers' main goal is to find solutions to prevent drug resistance towards cancer cells. Polyphenols in tea may play an important role in killing cancerous cells by preventing growth. In addition, countries such as Japan and China have lower cancer rates, which have been partially attributed from their regular consumption of green tea. Therefore, I experimented with two different types of tea, green and black, in order to see their effect on Baker's Yeast. I streaked yeast on agar of the Petri dishes ensuring there was an equal distribution of the yeast cells on the agar. I tested difference concentrations of green and black tea by soaking the paper disc in each concentration. The concentrations began with 10% variations (10% dilution, 20% dilution) and became more specific after each result. After five days of incubation, the zones of inhibition were measured in order to gain data showing the efficiency of green and black tea. In addition, one Petri dish containing green tea dilutions and one Petri dish containing black tea dilutions were used to further explore the research done on Chinese women chewing green tea leaves. The dilutions were mixed with human saliva and incubated for five days. After the incubation period, the zone of inhibition was measured and compared to the green and black tea dilutions without human saliva.

MDM2, or murine double minute 2, is the major regulator of p53, inhibiting its function. p53 is a critical protein that can inhibit the cell cycle and promote cell death. p53 prevents the formation of tumors. In fact, a normal cell rarely becomes a cancerous cell if p53 works properly. Therefore, MDM2 is a key gene involved in human cancers. MDM2 inhibits p53 by destroying the p53 protein. Clinical efforts are underway to reduce MDM2 levels in order to increase p53 activity, but more must be known about MDM2 in order to conduct these trials. The mouse MDM2 gene and its helper MDMX will be aligned with the genomes of a variety of invertebrates using the Basic Local Alignment Search Tool on the National Center for Biotechnology Information database. The result of the alignment will provide evidence for how similarly vertebrates and invertebrates regulate p53. The model species Tribolium castaneum will be injected with MDM2-like double stranded RNA, breaking down the MDM2-like mRNA within the beetles. This RNA interference cannot be conducted with vertebrates because mice lacking MDM2 die as embryos. A gene knockdown of MDM2 by RNA interference inactivates the gene within the organism, enabling the functions of the gene to be examined by observing how the organism develops without the gene. The beetle larvae will be observed under a microscope to see how the MDM2-like gene affects development. A control injection of EGFP dsRNA, which is not present in the T. castaneum genome, will ensure that results are due solely to the lack of MDM2.

Bibliography
How Does the Energy Drinks Effect the Birth and Death Rate on Fruit Flies

Abstract
The purpose of this project is to determine which energy drink will effect the birth rate or death rate of fruit flies. The question for this project is will any of the energy drinks affect the death rate, the birth rate or the larvae development? The hypothesis is that red bull will give the drosophila melanogaster an increased heart rate and over time they will die. The research will prepare the standard drosophila medium using 100% with solution water. The other vials to be studied will be prepared by wetting the media of 50% water and 50% energy drink, and an undiluted energy drink. The energy drinks that will be used are: zip fizz, red bull, rip it, 5 hour energy, rock star energy, and amp energy. The scientist will mix the energy drinks in the fruit flies food and observe them for 4 weeks. Results are still being collected.

Bibliography
Appetite regulation is crucial in mediating body weight and limiting obesity. Two key populations of neurons involved in appetite regulation are the GABAergic appetite-activating AgRP neurons of the arcuate nucleus and the glutamatergic MC4R-expressing neurons of the paraventricular hypothalamus (PVH). Studies have shown that each of these neuronal populations may be quite heterogeneous, with individual neurons performing different functions based on where they project to in the brain. In order to find genetic markers that define these neuronal populations, single neuron RNA-seq was performed to determine the transcriptional state of individual neurons. RNA-seq provides an unbiased and comprehensive snapshot of what is being expressed within a cell at any given time. By comparing the transcriptional signatures of individual cells using hierarchical clustering and principal component analysis, I have identified a distinct subpopulation within the AgRP expressing neurons of the arcuate as well as at least three distinct populations of MC4r expressing neurons of the PVN. I have further identified candidate markers of these neuronal subsets that can be used in the future to validate these subpopulations as well as to better study whether these subpopulations have important functional differences. Knowledge of these neuronal subpopulations and their functions can lead to more accurate and rational drug targeting of specific neural subpopulations, thereby reducing side effect profiles and leading to more effective control of body weight.

**Bibliography**

Circadian Timekeeping in the Drosophila Brain

More than 22 million Americans suffer from sleep disorders, and about 78.6 million Americans suffer from obesity. The studying of circadian rhythms, which influence sleep-wake cycles, hormone release, body temperature, and other bodily functions, may offer a way to discover more effective solutions for relieving sleep disorders and obesity along with other health problems such as diabetes, depression, bipolar disorder, and seasonal affective disorder. To examine how the master clock neurons’ arbor morphology changed in circadian rhythms regulating the body’s physical, mental, and behavioral changes, the effect of Fas2, Unc5, SGG, and w1118 expression during different developmental periods on neuronal morphology of the small ventral lateral neurons in the Drosophila melanogaster brain was investigated. Gene expression was controlled spatially and temporally using the GeneSwitch/UAS system. Observations of neuron arbor morphology were made through data analysis of length and area of on confocal microscope images of sLNv neuron axons in D. melanogaster brains fixed at ZT2. Here it will be shown that if different developmental genes Fas2, Unc5, SGG, and w1118 are expressed in Drosophila melanogaster, then flies with genotypes resulting from crosses of w;+;UAS-Fas2 x PDF-GS(III) and w;+;UAS-UNC5-HA x PDF-GS(III) have a decrease in sLNv neuron arbor area, w;+;UAS-Fas2 x PDF-GS(III) have a decrease in sLNv length while w;+;UAS-UNC5- HA x PDF-GS(III) have an increase in sLNv length, and flies with genotypes resulting from crosses of w1118;+;+ x PDF-GS(III) and w;+;UAS-SGG kinase dead x PDF-GS(III) will not have changes in length or area at ZT2.

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The effect of cold temperatures on different types of oils

People who live in areas such as Michigan, New York, Canada, and Alaska are exposed to extremely cold temperatures during the winter. The harsh climates make it very difficult to drive in these weather conditions. Snow and icy roads aren’t the only issues during the winters of these frigid areas. The car’s motor oil’s viscosity can affect the potential of an engine to run during these times. The viscosity of motor oil in general at room temperature is 150 mPas. Synthetic oil it is 144 mPas, which is low compared to other oils. Synthetic oil is usually a substitute for most petroleum lubricants. Synthetic oil is used in aircraft engines as well as metal stamping to provide better traction. Synthetic oil is one of the more expensive oils as well. Multi-Grade oil has an approximate viscosity of 153 mPas which is higher than the average. This type of oil has many additives such as polymer to protect the liquid from extreme temperatures. Multi-grade oil is widely used as motor oil for many cars and other vehicles. Single-Grade oil is commonly used by cars. The viscosity of Single-Grade oil is various between different brands but is usually not too high. Multi-Grade and Single-Grade oils are usually preferred by drivers in extreme temperatures due to their additives. However, Synthetic oil also contains some additives and has proven sufficient in extremely cold temperatures. When certain oils go through cold temperatures, the air causes the particles of the oil to slow down. The oil does not freeze due to its additives, thus causing the viscosity of the oil to rise. Research has shown that if the viscosity of motor oil is very high, then it will not be able to lubricate the engine therefore preventing the car from running. Most oil companies believe the additives provided are enough to counter these temperatures, they are wrong. Issues with engines not starting during are because of this flaw in motor oils. Even though all motor oils are affected by extremely cold temperatures, there are some who are least affected than other motor oils. Studies have been made to help provide a type of “all-season” motor oil. These have put many types of motor oil under that term. This experiment will use Synthetic, Multi-Grade, and Single-Grade oils and put them under certain extreme temperatures for periods of time. A specific “all-season” oil will hopefully be concluded after this experiment.

Abstract

People who live in areas such as Michigan, New York, Canada, and Alaska are exposed to extremely cold temperatures during the winter. The harsh climates make it very difficult to drive in these weather conditions. Snow and icy roads aren’t the only issues during the winters of these frigid areas. The car’s motor oil’s viscosity can affect the potential of an engine to run during these times. The viscosity of motor oil in general at room temperature is 150 mPas. Synthetic oil it is 144 mPas, which is low compared to other oils. Synthetic oil is usually a substitute for most petroleum lubricants. Synthetic oil is used in aircraft engines as well as metal stamping to provide better traction. Synthetic oil is one of the more expensive oils as well. Multi-Grade oil has an approximate viscosity of 153 mPas which is higher than the average. This type of oil has many additives such as polymer to protect the liquid from extreme temperatures. Multi-grade oil is widely used as motor oil for many cars and other vehicles. Single-Grade oil is commonly used by cars. The viscosity of Single-Grade oil is various between different brands but is usually not too high. Multi-Grade and Single-Grade oils are usually preferred by drivers in extreme temperatures due to their additives. However, Synthetic oil also contains some additives and has proven sufficient in extremely cold temperatures. When certain oils go through cold temperatures, the air causes the particles of the oil to slow down. The oil does not freeze due to its additives, thus causing the viscosity of the oil to rise. Research has shown that if the viscosity of motor oil is very high, then it will not be able to lubricate the engine therefore preventing the car from running. Most oil companies believe the additives provided are enough to counter these temperatures, they are wrong. Issues with engines not starting during are because of this flaw in motor oils. Even though all motor oils are affected by extremely cold temperatures, there are some who are least affected than other motor oils. Studies have been made to help provide a type of “all-season” motor oil. These have put many types of motor oil under that term. This experiment will use Synthetic, Multi-Grade, and Single-Grade oils and put them under certain extreme temperatures for periods of time. A specific “all-season” oil will hopefully be concluded after this experiment.

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Spectroelectrochemistry, a combination of spectroscopy and electrochemistry, offers many advantages over conventional spectroscopy or electrochemistry, allowing both electrochemical and spectroscopic data to be recorded simultaneously in a controlled manner. Having rapidly grown in recent times as a result of better accessibility, low cost, and few barriers to application, it enables researchers to better analyze electron-transfer processes and complex redox reactions, studying the energy & mechanism of a reaction along with the identities of the participating species.

In traditional electrochemistry, only the small amount of sample which is able to diffuse to the surface in a given timeframe can be electrolyzed; even with more modern techniques, such as thin-layer spectroelectrochemistry, small volumes can be electrolyzed extremely quickly, but the resulting samples are unusable. The goal of this project is to develop the ideal thick-layer spectroelectrochemical cell, enabling the rapid, exhaustive electrolysis of large sample volumes.

Experiments were conducted using a UV-visible spectrometer, potentiostat, and spectroelectrochemical cell consisting of a 1-cm quartz cuvette and working (carbon fiber), counter, and reference (Ag/AgCl) electrodes. Different properties and configurations of the electrodes were tested, and reference & counter electrodes which extended outside of the cuvette were developed. Each experiment was conducted for 1 hour, with spectra taken every 30 seconds as a constant potential of 0 V was applied. The standard reaction was the reduction of ferricyanide to form ferrocyanide.

It was determined that carbon fibers could cross the optical path of the cuvette, and that the rate of bulk electrolysis increases as the diameter of the gel plug in the counter electrode is increased, or as its conductivity is decreased. Platinum wire proved to be the ideal counter electrode material. In addition, the electrolysis of ruthenium (II) bipyridine to form Ru(III), an unstable substance, was achieved, indicating a promising future for thick-layer spectroelectrochemistry.

Anthocyanin TiO2 solar cells, chlorophyll TiO2 solar cells and silicon solar cells were compared based on amperage and voltage. Silicon solar cells were predicted to be the most efficient, anthocyanin solar cells were to be slightly less efficient and chlorophyll solar cells to be the least efficient. Conductive glass slides were measured for resistance. Titanium dioxide was mixed with ascetic acid, water, and tritinex. After being baked on a hot plate, it was applied thinly to the conductive side of a slide. Dye was removed from leaves or raspberries using a mortar and pestle. It was combined with acetone and dripped onto the titanium dioxide layer. The other glass slide was coated with carbon from candle smoke. The solar cell was put together with the carbon side facing the titanium dioxide. The ionic solution was dripped along the offset portion of the slide and permeated the entire slide. The solar cell was attached to alligator clips and the voltage was measured. A 16-watt light bulb was moved along a ring stand. Amperage was calculated based on resistance and voltage. At the highest light intensity, the silicon solar cells had the greatest voltage, 254.2 mV, the chlorophyll solar cells had 97.1 mV and 1.07 mA, and the anthocyanin solar cells had 92.4 mV and 1.04 mA. At lower light intensity, the anthocyanin solar cells had greater voltage and amperage than the chlorophyll solar cells. At ambient light, the anthocyanin solar cells and the chlorophyll solar cells surpassed the silicon solar cells.

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Current drug delivery systems such as hydrogels and nanoparticles pose substantial limitations which we must consider. For example, there have been problems with hydrogels leaking their contents prematurely. Furthermore, many nanoparticles raise toxicity risks, as the inhalation of such particles may cause pulmonary inflammation and blood coagulation. However, liposomes, which are vesicles composed of phospholipids, hold promise as a potential novel, alternative system for use in biodegradable drug delivery. The specialized phospholipids of thermoacidophilic archaebacteria are of particular interest for lipid membranes because they allow archaebacteria to survive in conditions of extremely low pH (as low as 0.7) and high temperatures above 100°C. The hardness of such phospholipids suggests that they may have potential applications in liposome-mediated drug delivery.

This study examines the effects of 4 unique structural characteristics of thermoacidophilic archaebacteria on membrane proton permeability: branching of hydrophobic tails, ether linkages, transmembrane tethering of hydrophobic tails, and cycloalkanes within hydrophobic tails. Hypothetically, these unique structural characteristics of archaebacterial phospholipids would make such membranes less permeable to proton flux than membranes of most other organisms, thus acting as the mechanism to allow the thermoacidophilic archaebacteria to withstand the high pH gradient of their environment.

To test the hypothesis, the proton permeability of both standard phospholipids and synthetic archaebacteria-inspired phospholipids was measured using a modified fluorescence-based assay. The first objective of this experiment involved resolving discrepancies between published and experimental permeability values by testing the effect of valinomycin concentration on permeability. After resolving the issue of valinomycin, the modified assay was used to compare permeability of vesicles composed of standard phospholipids such as POPC, di-O-PhyPC, and diPhy-PC, as well as novel synthetic archaebacteria-inspired phospholipids.

Paula, S., et al. Permeation of Protons, Potassium Ions, and Small Polar
Social Media has become a vital part of how human’s communicate. Over 74% of internet using adults use some platform of social media, with 1.3 billion Facebook users, and around 500 million tweets per day. Communicating through social media has transformed the way we think, speak and interact.

Social media has not reached everyone, many disabled people, especially visually impaired people are excluded from mainstream social media platforms as they are not designed for them. During times of crisis (or natural disasters), most of the immediate communication occurs on Twitter and Facebook.

In this interdisciplinary computer science and social experiment, I created a novel application for visually impaired people to interpret the social media tweets using speech input and and traverse depths of social media as speech output. This application uses Web Speech Synthesis API’s to convert speech to text and text to speech, and Twitter APIs to mine tweet datasets.

During a crisis, the visually impaired can use this application to search for relevant tweets from a credible news source or search based on the crisis keywords using audio input. The resulting tweets are converted into an audio format and efficiently played and easily navigable.

For getting the sources of information during a crisis, I used Crisis Lex, which is a lexical of most frequently used hashtags during crisis, which I used for the testing aspect of my project.

Communication and interaction through social media are part of our lives and my goal is to expand its reach and create an inclusive society. This experiment opens the doors to a wide array of wearable devices which can communicate with audio inputs and deliver audio outputs of social media streams.

The blind participants of this study had sheer joy using this application to search various different tweets from “weather” to “jokes”, and enjoy audio tweets for the first time. It is an example of technology impacting a large population, again. The whole project is open source and available for the community to use and innovate.
Abstract

A smartphone App was developed that gathers data about the condition of a gravel road using the sensors built into a modern smartphone. When the App is running and the smartphone is in a car being driven down a road, the App will use the phone’s accelerometer to measure the vertical acceleration that the car encounters. It uses the phone’s GPS receiver to determine the position of the car and measure its speed. It records this data in a file that can be opened with Excel where it can be analyzed.

The App was used to obtain data about three different road conditions: a newly paved stretch of highway that acted as a control, a gravel road that was in good condition and one that was in rough condition, in need of being graded. By analyzing the data in Excel, a procedure was found that produced a number that correlated with the road condition. Dividing the vertical acceleration by the current speed produced a number that matched well with the road conditions. When this number was 0.20 or below, the road was mostly smooth. When the number was over 0.40 the road was mostly in a rough condition.

This project could continue to be enhanced to provide real-time information about a road’s condition, just like real time traffic Apps can report road congestion. Geo-fencing could also be added so that roads of interest could be defined offline and the phone could automatically report data if it detected that it was on a particular road.

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Large amounts of salt application threaten human and ecological health in a major way.

Question: How does increasing concentrations of rock salt effect germination and plant growth.

Hypothesis: If the concentration of rock salt is increased in the soil then there will be a delay in germination and plant growth.

Procedure:
• Obtain a tray and place 25 4-oz foam cups in the tray.
• Fill foam cups with potting soil.
• Mark the first row as controls. (5 x 1)
• Mark the next 4 rows as test 1 through 4 (5 x 4 = 20)
• Insert red bean seeds in each seed pot at equal depth.
• Place the tray next to a window to ensure the same amount of sunlight for the controls and test pots.
• Using an electronic scale, measure 200 mg of salt and mix it thoroughly in 500 ml of distilled water to make a standard solution.
• Using a standard syringe, add 1 ml of this solution to all Test 1 cups.
• Add 2 ml of this solution to Test 2 cups.
• Add 3 ml of this solution to test 3 cups.
• Add 4 ml of this solution to test 4 cups.
• Using a beaker, water all cups with 5 ml of distilled water every day.
• Check daily for germination and measure growth with a standard ruler every day for 10 days.
• Take pictures of the tray daily.
• Tabulate and analyze results.
• Graph results.

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The goal of this project is to locate the epicenters of worldwide earthquakes using archived seismometer data from a global network. I chose significant earthquakes that happened from the past and plotted the data to the Global Seismic Network one at a time. After locating the earthquake on the map, I used the program to form Seismogram of each station. To analyze the data, I figured out the arrival time of both waves and calculated the difference in arrival times of the first S-wave and the first P-wave. Then I used the Travel Time Graph to find the distance from the station to the event. I drew a circle on the station map to indicate the possible locations for the earthquake epicenter using a compass. I repeated the process for several different earthquakes. Lastly, I compared the plotted epicenter location to the actual location of the epicenter given by the program to verify my result; they were relatively close. This is how scientists determine the epicenter of earthquakes.

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In the United States many people are burned with the inconvenience of hearing loss. People because of this loss have to deal with the downsides that come with it. Buying batteries is one of the major downsides. These batteries add up cost wise when they are needed to be replaced frequently and it can be a problem when they die and the batteries have to be changed. In this experiment a thermoelectric generator will be tested to see if it can come up with enough power to be able to power a hearing-aid. A thermoelectric generator works by one side being cooled and the other side heated forming a delta T. The average temperature of the spot on the head behind the ear is 34 degrees C, this temperature and other various surrounding air temperatures will be tested for the cooling side. The temperature of behind the ear which I 30 degrees C will also be tested with various surrounding air temperatures. both these spots will be tested for the amount of power made and if it's enough to power a hearing-aid.
Abstract

In civil engineering, Aggregates (compacted minerals) are vital in the composition of Asphalt; their fundamental properties such as area, equivalent diameter, and shape define the end product ranging from a crumbling road to a solid foundation. The purpose of this project is to develop a low cost aggregate image analysis system. Aggregates play a key role in the performance of the asphalt pavements. Measurement of their properties is crucial in determining their appropriateness to be used in asphalt pavements. Conventional methods for measuring aggregate properties such as form, aspect ratio and angularity are subjective and time consuming. With the advent of affordable smartphones, it is possible to obtain high quality images of aggregates and use image processing methods to compute their properties.

The objective of this project is to develop a methodology to measure the properties of aggregates using smartphones such as an iPhone. By deducing a method to analyze Aggregates more affordable and effectively; which will yield a wider arena for the implication of this software and will led to lessened amounts of time spent analyzing Aggregates by hand; In addition, the application will provide a more economically feasible way of sorting the Aggregates by offering a program, that roughly cost one sixty-fifth (six-hundred ninety-two dollars) the cost of the analysis camera and software which is typical about forty-five thousand dollars.

The approach, to simplify this issue was to write an image analysis algorithm that could deduce the sought properties and complete the task in a more efficient manner. In sum, the algorithm completed the task at hand such as the measuring for aspect ratio, area, and angularity.

Downfalls of the software consisted of having rudimentary knowledge of coding to be able to run the software with multiple images, another issue was that some aggregates were so fine that light was re-emitted completely and the program assumed the aggregate as not being present. The application performed well in the aspects it was designed for, it also found all properties sought ever time with little to none flawed outcomes.

Bibliography

This experiment explored the connection between winglet angles and standard deviation of lift. A winglet is the part of a wing of an airplane that is bent upwards. A winglet’s purpose is to prevent the air going over the top of the wing from meeting the air going underneath the wing. If the two were to meet, they would create a vortex at the wingtip that increases drag, thus making the flight less efficient. This experiment’s purpose was to see how winglets of different angles effect the smoothness of a flight. The smoothness of a flight was measured with the standard deviation of lift. The greater the standard deviation, the more turbulence, and therefore a rougher ride. The wing was designed in a 3-D designing program to have a slot at the end in which winglets could be inserted and swapped out. Using a force sensor, each separate winglet was tested in the wind tunnel with the fan at its highest setting. There were five winglets: 90, 105, 120, 135, and 150 degrees. A control was also performed with no winglet. A force sensor was attached to the wingtip of the wing to measure lift. As the fan ran, the sensor recorded a measurement in newtons of force fifty times a second for ten seconds. The results showed a general trend that the lower the angle, the smoother the ride, the only outlier being the 120 degree winglet, which had the lowest standard deviation.

Bibliography

DOI Number
1-s2.0-S1631072111001938DOI Number
1-s2.0-S1270963810001586
In an effort to allow the elderly to remain safely in their own home, this microcontroller was engineered to combine a variety of valuable functions including monitoring with a high degree of accuracy for (1) falls, (2) the absence of movement, or (3) the pressing of an emergency button and immediately contact a caretaker in case of an alert. The fall detection feature was designed to expediently notify a caretaker of a fall. The absence of movement monitoring feature, not currently available on any product, contacted help in case of other medical emergencies when the user could not move. The emergency button allowed the user to easily call for help in any situation. The device had a "sleep" function and an alert canceling button. A microcontroller with a Bluetooth module, LCD display, touch sensor, and accelerometer were programmed in Python to accomplish these objectives. A computer was programmed to continuously monitor for alerts via Bluetooth and text a caretaker if one is detected. The device was tested to determine the optimal sensitivities by having subjects wear the device while conducting "normal" activities, wear the device while not moving, and allowing the device to fall. Analysis of the data revealed the device was very effective. It never reported a false-positive and there was a high level of accuracy for detecting falls, with the highest sensitivity having a seventy percent level of precision. The device always alerted in the no movement trials. This device will provide seniors the confidence to live independently.

Bibliography


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In the United States, nearly 1 in 100 babies are born with heart defects. Defects such as heart valve deficiency cannot be treated so easily, causing the infants to have open heart surgery every year. To settle this issue, we contributed to a study of chitosan-based material properties that can be used to engineer tissue, which can be applicable for mechanical body parts. Chitosan was the main focus in this research. It is a polyelectrolyte with reactive functional groups, gel-forming capability, high adsorption capacity, and biodegradability. The objective of the research is to make the tissue materials stronger. Thus, in this study, we also used glycidyl methacrylate (GMA) chitosan fibers with UV cross-linking and the process of annealing. With those fibers, we first tested their resilience with the tensile testing. We then, included the fibers in the scaffolds and tested the strength of fiber embedded scaffolds.
Abstract

My project, peltier tile solar panel, was designed to solve the problem that so many in this growing electric world still have no access to electric light (over one billion people). This would be solved by a peltier tile solar panel, which would use the thermoelectric effect to create electricity.

The solar panel would be constructed of cheaper materials which would be effective as well as cost saving. The panel would be put on a roof, with one side facing toward the sun and the other side would be under the roof. The solar panel would be constructed of cardboard with one side painted black with a conductor (aluminum) and one side painted white with a insulator (cellulose). The peltier tile would be placed within the center of the panel, and between the two sides. The light would be placed under the panel. The importance of cheap materials is that many in poorer countries cannot afford much more expensive solutions, and would pick items for survival (food) over the project.

The data I need for project is the exact temperature on both sides of the peltier tile so I can make sure that the tile creates at least 2.5 volts (minimum needed to power light bulb). I got this data by heating (hot plate) or cooling (heat sink) both sides to the temperature I expected and recorded the results. I expected the hot side to reach between 65-95°C and the colder side to reach 17-24°C. I reached these temperatures after studying the absorption of heat by similar contraptions, and the climates of the areas I want my project to target. Gladly, most of the temperatures reached the 2.5 volt mark, but some didn’t. The temperature differences which did not reach 2.5 volts would be solved by a different circuit, such as a voltage doubler.

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The purpose of this experiment was to determine the optimum pressure to pump perfluorocarbon (PFC) and saline into a silicon-based chip containing either T- or Y-junction(s) to create monodisperse PFC microdroplets quickly and in high concentration. Two pumps controlled the pressure in two chambers, one containing saline and the other the PFC. As pressure in the chambers was increased, both PFC and saline were forced through their respective tubes and into the chip junctions. Chamber pressure was varied to examine its effect on the resulting emulsions of PFC microdroplets. Emulsions were measured for droplet concentration and size distribution, and the droplet production rate was then calculated. A large coefficient of variance was noted, indicating emulsions produced at the same pressures had different size distributions. Microdroplets can be effectively used for medication delivery only if they are monodisperse under reproducible conditions. These experiments show that this method of chip setup is a viable procedure for microdroplet production, but additional modifications will be required to obtain consistent results.


Biodegradable orthopedic implants have recently gained attention because they facilitate the avoidance of multiple surgeries. Although polymeric bone plates have been found attractive due to their ability to last up to a couple of years and degrade by hydrolysis, their low Young’s modulus is a limitation. Magnesium and its alloys, on the other hand, have strong potential for orthopedic implants due to their established biodegradability, biocompatibility and bioabsorbability. This investigation focused on the magnesium alloys, AZ31, AZ61 and AZ91, for bone plate application during fracture fixation. The purpose was to assess the time for dissolution of the magnesium alloy bone plates, manipulate design features to suit a desired healing time, and evaluate the impact of degradation on the mechanical performance of the implant. The hypothesis was: If the corrosion rates of the alloys are known, then the alloys could be engineered for biodegradable bone plate applications through the manipulation of design to accommodate time for healing. The mechanical performance could potentially be predicted based on degradation kinetics. To test this hypothesis, the corrosion rate of AZ31 was established in prior experiments. Corrosion data of AZ61 and AZ91 from literature was also used. These data were utilized to manipulate bone plate geometry and determine the material’s longevity in the human body. The change in the mechanical performance of the degrading plate was assessed. The hypothesis was proven to be correct. The chosen magnesium alloys could be engineered as candidate materials for biodegradable bone plate applications through intelligent manipulation of design.

**Bibliography**

Accelerated Sintering and Retarded Grain Growth of 3Y-TZP Ceramic under AC

Abstract
This project included an improvement upon current formation conditions for a type of ceramic, Yttria-Stabilized Tetragonal Polycrystalline Zirconia (3Y-TZP). Presently, ceramics undergo sintering at high temperatures for long periods of time, leading to larger grain sizes and consequently, higher costs and a lower quality. The objective was to reduce the temperatures, shorten the sintering time, as well as slow down grain growth in 3Y-TZP. This was achieved through the use of a low voltage alternating current (AC), which markedly accelerated the formation of full density grains at a lower temperature and shorter sintering time, and retarded the grain growth during sintering.

A 3Y-TZP ceramic specimen's shrinkage was measured, and its grain sizes were recorded. Through the application of 20V AC, temperatures decreased from 1500°C to 1200°C, and sintering time was reduced from 7200 to 3000 minutes. Microstructure data showed that grain growth slowed, with sizes halving from 400 to 200 nanometers while still achieving maximum density. The results indicated that the electrical energy obtained from AC accelerated sintering by allowing atoms to move faster; at the same time, activation energy was increased, thus retarding grain growth. This technique could ultimately be applied to the sintering of other types of ceramics, having an impact on the pervasive ceramic industry.

Bibliography
Physiological and Behavioral Impacts of a Neonicotinoid and its Metabolite

Abstract

Imidacloprid (IMI), the most utilized insecticide in the world, is an emerging contaminant. It belongs to a class of compounds known as “neonicotinoids,” which act as post-synaptic nicotinic acetylcholine receptor (nAChR) agonists. 6-CNA occurs as a result of photodegradation of IMI. Little study has been devoted to potential ecological consequences of exposure to transformation products. No current legislation pertains to the control of neonicotinoids or their transformation products in the environment. No follow up to agonist-antagonist interactions in cholinergic systems has been performed in the past 50 years. Primary objectives of this study were determining toxicity of IMI and 6-CNA, through the assessment of physiological and behavioral biomarkers in Daphnia pulex, a non-target keystone species, and the elucidation of cholinergic mechanisms of the microcrustacean central nervous system. Heart rate (HR) and appendage beat rate (ABR) in response to chemical challenges (IMI, 6-CNA, and nAChR antagonist mecamylamine) were monitored and analyzed through the application of the novel optical tracking method and quantification of density-intensity discrepancies. Behavior was assessed through optical tracking of cumulative distance traveled and angular change. IMI was determined to be sublethal at 0-256 microM for a period of 24 hour exposure. Increasing concentration-dependent changes in accumulated distance traveled (increase) and angular change (decrease) were established. Two-way ANOVA with repeated measures was used to determine statistical significance. At a concentration of 256 microM IMI, ABR rate was decreased by over 50%, p < 0.05. Decrease in ABR motor function resulted in a lack of oxygen consumption, decreased filtration, and decreased food intake. These factors combined can lead to maladaptive practices by Daphnia that undermine their abilities to find a mate, food, or escape predation. Little change in HR was observed as a result of IMI exposure. This may be due to nAChRs not modulating heartbeat. Physiological change as a result of 6-CNA exposure at similar concentrations as those used for IMI yielded no change during the 60 minute exposure period. The bioaccumulation of insecticides, metabolites, and other chemicals in aquatic systems can result in abnormally high concentrations and lead to negative synergistic effects on aquatic wildlife as well as contamination of drinking water sources.

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Simulation of the Removal of Microbeads from Facial Scrubs by Wastewater Collection and Treatment Facilities

Microbeads are bypassing wastewater treatment facilities and getting into the water. Once in the watershed, microbeads are causing damage in the environment. The microbeads absorb existing toxins such as pesticides and motor oil. When a fish mistakes the microbeads for fish eggs and consumes them, the fish are also consuming the toxins. When a predator, such as yellow perch, consumes the fish, the toxins move up the food chain, thus, damaging the ecosystem. The experiment replicated the conditions of a local wastewater treatment facility. The experiment focused on the most probable points of capture that are screening and the aeration/skimming process. The original hypothesis was that no microbeads (0%) would be captured. This research showed that about 48% of the microbeads were captured leaving 52% to flow into the watershed. Even the latest technology in wastewater treatment is not able to capture these microbeads and it would be expensive to redesign the system in every city. Therefore, it would be most logical to ban microbeads in personal care products.

Bibliography


In my experiment I was testing which type of compost ingredients would produce the most biomass. The three ingredients that were experimented with were cow manure, moss, and the control was distilled water. To find which produced the most, the air was stored in a balloon on the top of a bottle and all the biomass was stored in the balloon. The circumference of the balloon was taken each day and the maximums were recorded.

An increase in the natural suspended sediment concentration (SSC) of water indicates a threat to the health of aquatic ecosystems. Excess sediment blocks sunlight to aquatic plants, suffocates fish and invertebrates, and may indicate the presence of runoff carrying invisible chemicals and pathogens. This experiment provides a way for a person with a cell phone to monitor changes in SSC. Different SSC levels were prepared in a garbage can and pictures of the water and a reference paper were taken with an IPhone 3GS camera. The pictures were uploaded into the application Gimp and three color values (red, green, and blue) for five points in the water and one point on a reference paper, a normalizing factor, were recorded. This data was analyzed for correlation, and a function relating color values to SSC was found. The function can be used to develop a phone app that estimates the SSC from a picture taken on the camera. This app could be used by citizen scientists to monitor local streams and rivers.
I wanted to discover if organic plastic products could have the same qualities as normal petroleum products, namely the qualities of hardness and flexibility. I made plastic using corn, potato, and milk. I made sure they were of the same thickness as the normal petroleum plastic control item, a plastic spoon. Obviously, to do this, I needed some data. I made two scales. One was for flexibility, and the other was for strength. I also needed to have data from t-tests. T-tests would prove that my results are correct and agree with the hypothesis. I also needed to make some graphs to better relay the data, along with tables. The first step to getting my data was to perform my experiment. Then I made my hardness scale. It started off with 0, which meant too soft to break or no strength, 1 being that the object cracks/breaks after light force applied, 2 meaning breaks after some force applied, 3 meaning breaking with serious force applied, and 4 being survive after 2 hits with a hammer. My flexibility scale went from 0 to 3. 0 meant that the object doesn't bend at all, 1 being bendable up to 10 degrees, 2 being bendable to 40 degrees, and 3 being bendable to 90 degrees or more. I performed both tests to my controls and my organic plastics. Along with this, a graphing calculator (TI N spire CX) was used to perform the t-tests to support my data. That is how I obtained the data I needed and how I got it.

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This experiment was conducted to determine the effect of agitation period and/or varying amounts of yeast per yeast solution on the concentration of CuSO4 ions in a CuSO4 solution and the turbidity of the solutions. It was conjectured that if the CuSO4 solutions were treated with varying amounts of yeast per yeast solution in one test and with a standard yeast solution for different agitation periods in another test, then the solution treated with the greatest amount of yeast in one set of tests and the solution treated for the longest agitation period in the other set would have the lowest concentration of leftover CuSO4 ions and highest turbidity. The agitation period factor was tested in a series of trials wherein a standard CuSO4 solution and standard yeast solution were poured into a container and agitated by a magnetic stirrer for 2, 4, or 6 days, and the varying amounts of yeast factor in a series of trials wherein a standard CuSO4 solution and a yeast solution of 0, 0.1, 0.25, or 0.5 g yeast were poured into a container for four days. Samples from both tests were immediately measured by a turbidity sensor after a trial ended and then measured for leftover concentration of CuSO4 ions by a colorimeter after filtering out yeast. The results were that turbidity decreased and concentration of CuSO4 ions increased as the length of agitation period increased while turbidity increased and concentration of CuSO4 ions increased as the amount of yeast per solution increased.
Can Parallel Lines Diverge?

The experiment demonstrates the relationship of parallel lines on a non-Euclidean surface, meaning a surface that is not flat. In geometry, you learn that parallel lines never intersect and never diverge. That is because on a flat surface a line cannot diverge without intersecting, or else it would be a curve. However, non-Euclidean surface can alter a line’s path without the line itself curving.

The non-Euclidean surface the experiment is tested on is a hyperbolic surface. This can be best described as any surface that seems flexible and wavy. Parallel lines were started by drawing a short line segment, approximately one centimeter, on each side of a business card. Then a longer straight edge was used to continue the line segment. This was done for both segments. Measuring the distance of the lines at one end compared to another, it was found that as the lines continued, the space between them increased, showing that they had diverged.

Furthering the experiment, three points were drawn at random, and straight lines connected the dots. Upon measuring the angles, the discovery was made that the angles were equal to less than 180 degrees, impossible for a triangle on a flat surface.

To relate this to real life examples, the universe is structured as a hyperbolic surface. Massive objects bend space-time, creating a curve that is hyperbolic. Lines that pass by this curve will bend- exactly in the way on this test surface. This is theorized to be what causes light to look distorted when around a black hole.

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Surface tension manifests when the molecules at the top of a liquid have less liquid molecules to bond with, unlike the rest of the molecules in the liquid. This causes them to have stronger bonds with each other, creating a thin film on top of the liquid. Surface tension and surfactant interactions (as in soap bubbles), are capable of forming many different 2d and 3d shapes, which are produced to create the optimal surface area. The optimal surface area has the least surface area to volume ratio, and is formed because it requires the least energy. This is why water forms spherical beads.

Motivation

In school we were reading a chapter about the chemical basis of life. That is where is first learned about surface tension. Later on we did an activity on calculating the surface area and volumes of certain 3d shapes and finding which shape had the least surface area to volume ratio. We did this to find out what the desirable shape for a cell would be. We found out that a sphere was the desirable shape. As I stated before, the sphere requires the least energy to be formed. Now I wanted to find out what other applications surface tension had in the real world. I encountered a problem about how to find the shortest path connecting a number of points and how to design the roof of a stadium with the smallest area. The first problem is called the Steiner tree Problem, which only deals with 2d structures, and the second one is an application of the plateau problem, which deals with 3d structures. These problems are very hard to solve theoretically, but very easy to solve with soap bubbles as shown by Joseph Plateau and Jakob Steiner in the 19th century.

OBJECTIVE

I want to use plateau and Steiner's methods, which uses soap bubbles, to demonstrate how to find the shortest path connecting some number of points, and how to design the roof of a stadium with the smallest area.

EXPERIMENTS

- Paperclip floating on water
- Pepper spreading in water
- Alveoli in lungs
- Boat propelled by surface tension
- Frame experiment
- 3D – cube
- Two Plates
- N number of towns/points
- Shortest paths between them

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Some continuous systems expand outward without boundaries. Other continuous systems approach center infinitely. The purpose of the Apollonian Packing method is to continue inserting smaller circles into the “lune” regions resulting from the continuous construction of “multi-tangent” circles. This project deals with the first two generations of the Apollonian Packing method. In order to find the radius of the inner Soddy circle, a prior knowledge of algebra and geometry is required due to the different calculations and mathematical language. Furthermore, possible applications can be considered when using the Apollonian Packing method with spheres instead of circles.

Bibliography


Abstract
This project experiments on the Seebeck effect and is measuring the amounts of energy outputted by this phenomenon by using various metal wires. Iron, copper, steel, and aluminum wire combinations will be tested. The Seebeck effect is when a voltage is created by two different conductors (metal wires) or semiconductors, with differences in temperature, in contact with each other. This phenomenon basically transforms heat energy into electrical energy. The Seebeck effect experiment contributes to real world uses; it produces a thermocouple, which is an instrumental device used to measure temperature. A thermocouple consists of two different metals, just as it is in the experiment. Although this experiment will produce very low voltage, it provides solutions to energy problems and helps make use of wasted heat energy when paired up with voltage amplifiers. Finding out which metal combinations works best helps make the most voltage out of the heat energy added.

The research question of this experiment is which combination of metals (from iron, copper, aluminum, and steel) produces the most voltage? The hypothesis is that aluminum and copper produce the most voltage. This is supported by the fact that copper and aluminum have low resistance to electrons and electricity. To do the experiment a thermocouple will be created using two different metals (from iron, copper, aluminum, and steel) at a time and items that will be needed include wire cutters, sandpaper, two banana plugs or connector pins, screws, multimeter with 1/10 millivolt (mV) resolution, a normal thermometer, drinking glass, ice cubes, water, water boiler and pot for boiling water, and a cup to hold hot water. First, the Thermocouple Thermometer will be created by using the multimeter, connector pins, and a thermocouple wire. After calibrating the Thermocouple Thermometer, the different metal wires will be attached to the multimeter part, using the banana plugs, of the Thermocouple and two separate areas called junctions will be created. At these junction areas, the wire will go into a cup with cold water and the other wire will go through a cup of hot water. This will be repeated for every metal wire combination. At one of the junctions (the measurement junction), the multimeter and Thermocouple are used to help calculate the temperature and voltage produced.

The temperature reading and voltage for each combination will be recorded using the multimeter and the Thermocouple and is compared at the end of the experiment. The combination with the highest voltage produced is what this experiment is aimed for. This will help solve the research question. One might think that there is risk in this experiment from the voltage, but there is no risk because the voltage will be in millivolts, which is too small to be a risk. The only danger is the risk of being burned when dealing with the hot, boiling water.

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Candles give off a lot of energy as heat, so how would they compare in efficiency against other sources for producing light, but more importantly, how could you take this heat and convert it into more light, improving their energy efficiency. This could have a huge savings for many people in the third world who rely on candles (and lamps) for light. The overall energy available from combustion may also be improved.

I measured light and heat output, compared that to calculations and other light producing systems, experimented converting heat to light, looked at renewable sources for the fuel, tried to see whether the burning could be controlled plus any benefits of doing so and tried adding conversion steps using modern technology.

From the result of these investigations I will try to design a more efficient candle.

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The transfer rate from a compact disc (CD) is proportional to the speed at which it spins. Manufacturers pushed the speeds as high as possible (~22,000 rpm). Above this speed CDs explode violently. Today, the fastest CD spin rate is 52x, approximately 10,400 rpm. Here I investigate the cause of this behavior. I began with the hypothesis that the centrifugal force is the primary cause as this causes high stress on the inner edge. However, my experiments show that it is bending of the disc that actually causes the rupture.
**Category** PH  **P30**  Astronomical Spectroscopy Using a Home Built Spectroscope

**Abstract**  
This experiment was done to discover if a home built spectroscope using a CD-R or DVD-R would be capable of measuring the spectra of various astronomical objects, including Comet Lovejoy (C/2014 Q2). The hypotheses tested were: 1. A home built spectroscope using a CD-R or DVD-R will be capable of measuring the spectra of various astronomical objects. Comet Lovejoy (C/2014 Q2) will also be observed and the resulting spectra will be precise enough to determine the composition of the gases that are being emitted from it. 2. The spectroscope using the DVD-R will provide a finer resolution of the spectra than the spectroscope using the CD-R. Various spectroscopes were built using the schematics on the website http://www.inpharmix.com/jps/CD_spectro.html under the title of “Jim’s Homemade Spectrometers.” The first two experiments were run to find the best equipment, telescopes and lenses with which to run the rest of the experiments. Experiments 3-7 were performed to gather data to test the hypotheses, and also to bring to light any flaws in the construction of the apparatus. Experiments 7-25 were done to gather additional data to test the hypotheses. It was concluded that a functional spectroscope had been built, although a useful spectrum of Comet Lovejoy was not gained, and that, while the DVD-R spectroscope had a finer resolution in the solar spectrums gained, further data was not attainable to additionally

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Joachim Koeppen, Institut f. Theoretische Physik u. Astrophysik at the University of Kiel, Denmark.
The speed of sound was calculated from measuring the frequencies of nodes in a standing wave at different points along a closed end tube. The frequencies of nodes were determined by finding a null in a microphone signal. The wavelengths and periods (the inverse of frequency) were then plotted to determine the speed of the sound. This technique was shown to be highly accurate yielding a measurement within 2% of the known value.
Abstract
The purpose of the experiment was to find out how different factors would affect the strength of eddy currents. Eddy currents are circular electrical currents produced within conductors by a changing magnetic field. The first factor that was tested was the conductivity of the metal pipes, which were copper, aluminum, and stainless steel, with the PVC pipe as a control. The other factors were the diameter of the conductive pipe, the slope of the pipe, and slits and holes in the pipe. For each trial, a neodymium magnet was dropped down the pipe and the time it took to reach the bottom was recorded. The results showed that increase in the conductivity increased the strength of the eddy currents and increase in the diameter decreased the strength of eddy currents. The results also showed that decrease in the slope caused the speed of the magnet to slow due to decreased gravity and increased friction. Finally, the results showed that both slits and holes caused the magnet to fall faster than in the intact pipe, and the holes caused the magnet to fall slower than the slits, because of interruptions in the eddy currents. All of my hypotheses were supported, however in the first variable, the thickness of the aluminum pipe was three times as much as the thickness of the copper pipe, which resulted in the aluminum pipe causing the magnet to fall slower than in the copper pipe, even though copper has a higher conductivity than aluminum.

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Category PH P33  Investigating External Interventions Applied to Football Headgear to decrease

Abstract

Peak acceleration has been used in many studies to explore Football helmet safety. In this experiment, a linear drop test from 152 cm (6 feet) was performed in the NOCSAE (National Operating Committee on Standards for Athletic Equipment) fashion with four interventions to explore differences in peak accelerations when compared the control, a bare helmet. Several systems were explored; a Schutt helmet liner (liner Pro Air 2 XL EA) inflated to 89631.8 newton's per meter squared (13 psi), Guardian Cap (XL), Hutchinson Inner tube a 31.8 centimeter (12.5 in) filled with air at (3psi), and a Dilatant solution (C27H48O20 and H2O). A Vernier Logger Pro 3 software program with a Go link interface was used to calculate the amount of peak acceleration. A number of quality measures including a blinded slow motion video were devised to improve the drop testing. The peak acceleration was found for each test trial. Eight drops tests were performed per every intervention. The results suggest the Guardian System and the Dilatant solution showed a significant difference in peak acceleration when compared to the control, a bare helmet. These interventions may help to improve safety and quality of the football helmets.

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The Meissner Effect: Understanding Superconductors

Abstract

In 1933, Meissner was able to levitate a magnet above a superconductor. Superconductivity can be achieved by decreasing a superconductor’s temperature below its transition, or critical temperature (Tc). This will cause the material’s resistance to completely disappear. Superconductors have pairs of electrons known as Cooper pairs by which a current is carried. Below Tc, the binding energy of a pair of electrons causes a separation of the pair states from the “normal” single electron states. Persistent currents in the surface of the superconductor, below Tc, causes it to display a form of perfect diamagnetism. The Yttrium Barium Copper Oxide (YBa2Cu3O7) pellet, a Type-II superconductor, was chosen to reproduce the Meissner Effect. YBa2Cu3O7 has a superconducting Tc of -180.15o C, above the boiling point of liquid nitrogen. Experiment I (Part A) shows a magnet will levitate when placed above a superconductor when it is cooled below its critical temperature. A circular neodymium magnet, one-eighth of an inch in diameter, levitated for thirty-two seconds above the YBa2Cu3O7 pellet before rolling off its position as the liquid nitrogen dissipated. In part B of the experiment, a larger multipole neodymium ring failed to levitate, possibly due to its size and/or multipolarity.

In Experiment 2, an ohmmeter was used to measure the resistance of YBa2Cu3O7 in a petri dish at room temperature in order to measure the resistance before and after immersion in liquid nitrogen. The superconductor’s resistance was 245 to 385 ohms (figure 1) before nitrogen immersion, and zero ohms after liquid nitrogen immersion (figure 2). An electric circuit using copper wires, a 6-volt (V) incandescent lightbulb, a 6V battery, an YBa2Cu3O7 pellet before and after immersion in liquid nitrogen, were used to observe whether the bulb will illuminate. The findings were that the drop of the superconductor’s resistance to zero ohms by liquid nitrogen did not make a difference in its capacity to conduct electricity and causing the bulb to light, as it remained unlit.

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