Pittsburgh Regional SCIENCE & ENGINEERING Fair
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84th Pittsburgh Regional Science & Engineering Fair

Senior Division

Behavioral and Social Science (SBS)

Student Project Abstracts

March 29, 2023

Notes to Judges

Students prepare Abstracts limited to 100 words that include the following:

- Purpose of the experiment
- Procedures used
- Data
- Conclusions
- Possible research applications
- Minimal reference to previous work
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- Should not include: a) acknowledgments, or b) work or procedures done by the mentor

Many students continue their research after the Abstract is submitted, and therefore the Abstract may not fully represent the Project.

Abstracts are available to the Judges prior to the Science Fair as an aid in pre-screening the Projects. Judging is to be based on the actual Project as presented by the student.

Project Numbers are assigned as XYYABC

- X: S – Senior Division (9th through 12th grade)
- YY: Category Name
  - BS – Behavioral and Social Science
  - BI – Biology
  - CH – Chemistry
  - CM – Computer Science and Math
  - EE – Earth and Environment
  - ER – Engineering/Robotics
  - MH – Medicine/Health/Microbiology
  - PA – Physics and Astronomy
- ABC: Project number
  - 1xx or 2xx – Individual student projects
  - 3xx – Team projects (2 or 3 students)

Behavioral and Social Science (SBS)

SBS100: Analyzing Northwestern PA Community Townhall Data for Improvement of Community Outreach for People Living with HIV in Pennsylvania

The use of community input in efforts to better construct engagement programs is crucial, especially when it pertains to combating and preventing diseases such as HIV. Through surveying, data analyzation, and contextualizing data, community feedback via town hall will be used for evaluation and new ideas. This will be done utilizing Qualtrics and researching good survey practices. While the survey will have community input, looking for the real responses and maximizing the questions reach is key. Looking for trends and patterns in the community responses will allot for the explanation of the data and implementation of community feedback into better ideas and improvements to programs.

SBS102: Mint To Be

A study by the University of Cincinnati found that peppermint helps people taking tests concentrate during tasks that require sustained focus. Peppermint is a natural remedy for boosting memory and concentration. The action of sucking on mints can also have a relaxing effect and increase focus. Many schools give out peppermints to their students before taking a big state test. In this experiment, participants will be taking a reaction time test with and without a peppermint to see if a peppermint increases focus and reaction time.

SBS103: Longitudinal Statistics and the Pittsburgh Girls Study

For my project, I will be examining the consequences of fetal cigarette and alcohol exposure on intellectual achievement in female youth. With the magnitude of children exposed to alcohol in utero exceeding 500,000 and one million to tobacco yearly, it is imperative that the cognitive and long-term intellectual ramifications of these substances are investigated. To conduct my research, I will be using a sample of 2,451 female youth from the longitudinal, community-based data from Pittsburgh Girls Study. Through maternal reporting of alcohol and cigarette use during pregnancy, two groups will be created: offspring exposed and unexposed to substances in utero. To measure intellectual achievement the following measures will be used: IQ scores, academic grades, and results from the Wide Range Achievement Test (WRAT) and Wechsler Intelligence Scale for Children Test (WISC). To calculate significance in the correlation between the two variables, I will use SPSS to find relationships in the performance of the cognitive test and exposure to alcohol or cigarettes. The only necessary means to execute this project will be a computer with the software Excel and SPSS and the specific dataset. The anticipated result is a direct relationship between lower performance on the cognitive test and fetal alcohol and cigarette exposure. Using a community sample dataset, the implications of this research are understanding the broad intellectual consequences on youth exposed to alcohol and cigarettes in utero.

SBS104: Peer Influence in Testing Environments

For my project last year, I was focused on different testing environments and how they affect student performance. In my research, I found that when students are not pressured by time, they are more likely to perform better. I found a lot of passion in my project last year, and found that it was not only something that I was successful in, but it was something that I cared about. As a person who struggles with anxiety over schoolwork and grades, I found that looking into the psychology of testing environments is something that works well for me. This year, I want to dive deeper into the psychology of what makes students do what they do while taking tests. My research question is as follows. Are students pressured by others in their room when taking tests? This year I hope to discover if students are affected by the actions of people in the room with them while taking a test. My hypothesis for this project is that when students take a test faster than other students, they are more likely to wait to turn in their tests.

SBS105: Amount of Sleep vs Amount of Energy

My project is on the amount of sleep someone gets overnight versus the amount of energy they have the following day. I wanted to research this topic because I was wondering why some of my classmates have more energy in the morning but get less sleep at night. My hypothesis is that the majority of my classmates will get less sleep and have less energy and that the amount of sleep they get will negatively affect them the next day. After I collected participants' consent forms, I emailed each student a google form with questions about what time they went to bed and what time they woke up. I then looked for signs of energy (tapping foot, not paying attention, nodding off, ect.) and graded them on a scale from 0 (no energy) to 10 (high/lots of energy). I did this 5 days in a row (Monday through Friday). At this time, my project is still in progress and I don't have data to share, but results will be available at the fair.

SBS106: Bolded Font Effect on Reading Speed and Comprehension

Many people may face reading difficulty. Whether it's that they can't keep their place, they skip lines and words, or just they can't retain the information. I personally find myself making these reading mistakes. My project tests if students can read a short story faster, and answer comprehension questions better if reading is in bionic reading format. In bionic reading, the first two letters of every word are bolded. I will compare the students' reading time and test score for a short story that is in a regular font, to a short story that is written in the bionic reading format. My hypothesis is that the students will both read faster, and score higher on the short story in bionic reading. I have not experimented yet so I have no conclusions. Data and results will be available on fair day.

SBS107: Screen Time vs Sleep Time

This project aims to determine if there is a correlation between screen time on teenagers' personal devices and the amount of sleep they get at night. One study found that 57% of teenagers who keep an electronic device in their room at night get less sleep than those who do not. While the recommended amount of sleep for teenagers is 8-10 hours, many do not get this amount. According to health guidelines, the recommended top screen time for high schoolers is two hours per day. For my project, consent forms were given out to students in grades 9-12, then a survey was completed by students who provided consent. The survey had simple questions including: What is your daily average screen time?; How much time do you spend on your phone before going to bed?; When do you go to sleep and wake up on school days? The survey also included a few questions regarding the quality of sleep students receive, and how energized and motivated they feel during the school day. It was hypothesized that students who spent more than two hours on their cellphones daily and spent more time on their cell phone before going to bed would get less than the recommended 8 hours of sleep at night, and the quality of sleep at night and motivation throughout the day would be worse.

SBS108: Impact of Exercise on Student Focus

In today's world, people face distractions all day every day. As a student myself, I know that I can attest to this, especially in a school setting. This is why I decided to test how exercise can affect a student's focus. I had one of my school's gym classes do a total of 10 minutes of running and 5 minutes of rest. The procedure was two minutes on (running) and one minute off (resting). My hypothesis was that exercise would affect a student's focus. After running the test and getting the results, I used a paired t-test to find the p-value which was .5544. While the hypothesis may be true, it can not be determined whether completing an exercise affects focus. In conclusion, exercise may be beneficial in maintaining a better focus span, but the statistical data collected was not enough to prove it.

SBS109: The Effect of Subliminal Stimulation on Human Number Generation

Subliminal messages are images, words or sounds that are presented to individuals in a way that is not consciously perceived by the mind. Such messages are often used in media and have been found to be effective when used to strengthen persuasiveness of advertisements. Short-form videos are becoming increasingly popular with the use of apps such as TikTok and Instagram and users continue to go back for more. The purpose of this project is to test the effectiveness of using subliminal messages in shorter video clips. Two different videos were created to test the influence of these types of messages, including one with a subvisual cue, and one with a subaudible cue. Participants were shown each video on two subsequent days, and then asked to complete a short survey directly after viewing. Videos were shown on different days in an attempt to eliminate any influence from viewing the clips back to back. While experimentation is still in progress, results will include comparisons between the effectiveness of subliminal messages and compare whether auditory or visual cues have a bigger influence.

SBS110: The Effects of Caffeine on Food Consumption

The intent of this experiment is to see if there is a behavioral change when organisms consume caffeine. I want to see the long-term effects of caffeine since I drink coffee and wanted to if there are indeed effects. However, others' research has shown that consuming caffeine has no noticeable effect. They also say that cockroaches prefer sweet-solid food and haven't said if they like their food with caffeine in it. I put it to the test and it looks like there are some behavioral changes in the cockroaches. I put cockroach food with caffeine resembling one serving of coffee, Monster (energy drink), and tea. By the end of the first week, some behavioral changes were noticed. Examples of this are they didn't scatter when the light was first turned on, seemed more active, and even fought. I am still in the process of experimentation, so more results and comparisons will be available on fair day.

SBS111: Finding Ways to Promote Healthy Eating in Kids

My project researched ways to include vegetables in children's diets in a more fun and enjoyable way. Vegetables have many benefits for children. They provide energy, vitamins, and antioxidants. They also prevent diseases later in life, for example, heart disease and strokes. Many children lack the consumption of vegetables. My study took place at Grace Church's after-school program. The program meets once a week and provides a place for children to have fun after school. Normally, the children never take the vegetables I offer them. I wanted to see if I made them look more appealing if it would affect the children's decision when I offer them the vegetables. On week one, I took data on how many children take vegetables from the normal vegetable tray which includes veggies and dip. On week 2, I collected data on how many children would take the veggie bugs. The veggie bugs are the vegetables and dip from the tray and are presented in a more enticing, fun manner. I compared whether the children took the vegetables more from the tray or when presented as veggie bugs. I hypothesized that the veggie bugs would be taken more because they are more appealing but, my hypothesis was proven wrong. The number of children that took vegetables on week one and week two did not change. In conclusion, making the vegetables more appealing did not change children's want to eat vegetables.

SBS112: Affects of High Heels on Everyday LIfe

Everyone knows what high heels are; we see it every day. But not everyone knows the effects that it could have. As someone who has had multiple foot injuries as well as feet hurting depending on the type of shoe they wear, I wanted to know if high heels had any definite impacts before trusting myself in them. Thus, I wanted to research the specific health effects - both mentally and physically - that high heels could have on people. To be able to answer my questions, I created a detailed google form survey that was shared out to others. It included several questions such as people's opinions on heels itself, their pain after a day of wearing them, as well as any foot conditions that they may have. With the responses that have been provided currently, I am able to analyze the data to certain questions with pie charts and bar graphs to see the ratio and percentages of certain questions. I am also able to learn further on the open-ended questions by going into the spreadsheet of the survey and reading the responses one by one. While there have already been many responses received, data collection is still currently ongoing and the final results of my research will be shared on the day of the PRSEF competition.

SBS113: The Effect of Color on Temperature Perception

The purpose of this experiment was to determine if color can influence humans' perception of temperature. Color theory has long influenced human life, which is why restaurants have warm-colored (red, orange, and yellow) logos and why doctors' offices are cool-colored (blue, green, and purple). Blue represents cold temperatures whereas red represents warm temperatures, and while it is unknown if they trick the brain into feeling their respective temperatures, it was expected that they would. If the brain is susceptible to color-temperature correlation, then it could be used in the medical field to help ease patients suffering from fever or hypothermia. While it wouldn't cure the sickness, it could make the patient feel more at ease and relieve some pain or suffering. To determine the impact of color, participants in the experiment were given three pairs of steel cubes, and each pair had one red cube and one blue cube. In the first pair, the blue cube was warmer, but it was colder in the second pair. Both cubes were the same temperature in the third pair. The experiment is still ongoing, but the collected data has so far shown that humans overall are not influenced by color in this way and will feel the correct temperature. Further testing will be done, and when the experiment is complete, conclusions will be drawn about the impact of color on the human perception of temperature.

SBS114: Factors Affecting Immigration Attitudes

Immigration is a divisive and polarizing topic in the United States. It is pertinent to investigate the factors affecting attitudes towards immigration, and interesting to conduct research in a new perspective on high school students. In order to do so, 32 students in the greater Pittsburgh area were surveyed on their attitudes towards current immigration levels in the US, the impact of immigration on the US, and the belonging of immigrants in the US. These attitudes were evaluated against the presence of an international boarding program at a respondent's school, a respondent's estimated time spent per week with international students, and a respondent's nature of contact (whether contact is more positive or negative) with international students. It was found that the presence of a boarding program at a student's school has no impact on his or her sentiments towards the current US immigration level and the impact immigration has on the US. Furthermore, contact time has a negative relationship with high schoolers' sentiments towards the current levels of US immigration. Result analysis is still in progress, and the effect of contact time will be presented on the science fair day. Furthermore, attitudes towards the belonging of immigrants will be evaluated against the effect of boarding programs and contact nature. The effect of contact nature on student's views on the impact of immigration in the US will also be investigated.

SBS115: The Effect of Visual Stimulus on Insight Frequency

Innovation and discovery depend heavily on insights; thus, finding the effect of visual stimulus on insight frequency can lead to greater development. A variety of ill-defined problems was given for participants to solve. Each problem was solved in three stages: participants worked consciously and actively in the first and last stages and performed an incubation task in the second. In the treatment group, participants focused on random stock photos (the visual stimuli) for their incubation task; in the non-treatment group, participants focused on nothing. Participants self-reported the number of insights. It was found that there was no significant difference (p-value .358) in insight frequency between the two groups using an independent samples t-test. However, estimated power was small (.078), so the results were, at best, inconclusive.

SBS116: Effect of Virtual Reality Gaming on Mental Concentration

I want to judge whether VR can improve concentration and help high schoolers concentrate in school. I do this by having 10 participants do VR then take a cognitive test. Then the other 10 doing the cognitive test then the VR. The cognitive test consists of sheets of 3 digit addition and subtraction then a memory test. They will do 60 minutes of VR. After a week they will take the cognitive test again and see if they improved.

SBS117: Social Media and the Affects of Mental Health

-With social media being the most commonly used thing amongst teens and young adults. People often link the development of depression and anxiety to social media since our teens really don't do anything besides just scroll through social media such as TikTok, Instagram, Snapchat, and ect. But is social media the number one cause of mental illness in our teens and young adults, or could those so-called myths be taken down by another theory. Is social media the leading cause of mental illness in teens and young adults? If I survey teens and young adults on their mental health before and after experimentation, then I should see if their mental status has been affected during experimentation. I expect to see a decrease of symptoms of mental illness once participants are surveyed again after experimentation. Each student who consents to participate in this lab would be required to take a survey on their mental state and average social media use before experimentation. Then once students take that survey, they will be instructed to try to stay away from social media as much as they can for at least a week. After that week is up, I will survey them once again on their mental state. I will then compare the results from both surveys and see if the person's mental health has went up or down. Final results will be available on Fair Day.

SBS118: Does Playing Sports Make Students Smarter?

Please visit student's exhibit for abstract

SBS119: Color Vs. Memory

The purpose of testing the relationship between color and memory is to determine how people could incorporate color into their lives. If color is proven to influence memory, students could use color as a study habit. It could change people's lives for the better. I hypothesize that the color will make people remember the words better. This is my hypothesis because specific colors could grasp participants' attention better than ordinary black words leading them to remember them better. To test my hypothesis I will being using a physiological test called free recall. Free recall is the name for the test when you ask a participant to memorize list of words and then repeat them. In my experiment I ask a participant to memorize a list of 10 6-letter words in black and then a color (red, yellow, or blue) over 45 seconds. Next, I talk to the person for 45 seconds and then ask them to repeat however many words they can back to me. I record the number and follow the same procedure for the remaining list. I had a total of 30 participants. Every person did the black list, and I had 10 people do each of the blue, red, or yellow. After collecting data, I calculated SD, RSD, averages, and made graphs to determine that the color of the writing had no affect on how well someones remembers the words. Additionally I ran a t-test, and found the p-value which led to the conclusion of null hypothesis.

SBS120: The Effect of Age on Implicit Bias

Background and Rationale: %u2018Implicit bias' is an unconscious bias towards an individual/ group based on characteristics such as race, gender, skin color, etc. Implicit biases subconsciously influence judgments and decisions resulting in social injustice. It's unclear if societal efforts at implicit bias reduction have been effective in lowering race and gender-based unconscious biases. Hypothesis: Implicit biases involving race and gender will differ across age groups and will be lower in the younger generation. Methods: Implicit Association Tests (IATs) are research tools to measure unconscious biases. I have created two secure, anonymous Qualtrics web-based surveys with embedded IATs from Harvard's %u2018Project Implicit,' one for adults %u2265 18yrs, with four IATs for race and gender (White-Black; White-Asian; Gender-Science and Gender-Career), and one for minors (13-18 yrs, parental consent required) with two gender IATs (Gender-Science and Gender-Career). Univariate and multivariate correlations, including Pearson Chi-square analysis, will be performed using SPSS. Results: My preliminary analysis from 38 respondents shows a trend towards decreased implicit bias for race (White-Black IAT) in < 40 yrs of age compared to >40 yrs (28.6 % of 60yrs had a bias for whites over blacks, Pearson chi-sq 0.07). However, no such age trend is noted for gender-career implicit bias. Majority of men (61%) and women (80%) had a gender-career implicit bias (associated women with family over career) with no difference across age bands. Conclusion: The study is ongoing with continued recruitment. Full results and conclusions will be presented at the science fair.

SBS121: Analyzing the Methods by which Students Learn

The growing movement of personalized and focused learning structures involving auditory, visual, kinesthetic, and reading/writing learning styles has been recently enveloping the nation. Past research on this claim of VARK (for visual/auditory/reading/kinesthetic) learning helping students has been heavily divided, as varying sources present numerous different supporting evidence for their respective sides. However, nearly all of these sources have only taken a look at this matter from a theoretical perspective - giving reasons that are supported only by rational thought. Few sources throughout the entire literary and online worlds have actually conducted experiments on the issue. Furthermore, no sources actually take into account the newer idea of multimedia teaching, which has been gaining a significant amount of traction in recent years. In order to truly understand the impact of these teaching structures, one must actually test the variables. In an experiment I conducted myself, participants were presented with information through various different means - including visual, reading, auditory, tactile, and multimedia - then asked to recall this information on a written test. The scores of these tests were collected and evaluated, allowing for a clear understanding of the actual effectiveness of these diverse learning styles, as well as the usefulness of multimedia teaching. From these results, it became clear that multimedia teaching was the most effective in memory retention, followed by visual, then kinesthetic, then reading/writing, and lastly auditory. The deviation on these results was extremely minute, at less than 5% between each result. This shows that not only are learning styles not as unique as previously believed, but the main methods of teaching actually did the worst. Auditory learning is the most prominent method of teaching within US schools, and it proved the least successful for memory retention out of all of the different styles. This would potentially have large implications for schools and the ways in which teachers teach their students, as in order to maximize the effectiveness of lessons, more emphasis would need to be placed on multimedia, visual, and kinesthetic learning over reading and auditory.

SBS122: How Sound Affects Taste

This experiment used human subjects to determine if and how sound affects taste. Different variations of sound: pitch, volume and tempo, were tested on how they affect each of the four tastes: bitter, acidic, sweet, and salty. When testing, every outside variable that can affect taste was prohibited, so this experiment was performed with the human subjects having blindfolds, nose plugs, and the experimenter handing that cup and straw to the human subject. Dilute solutions of each taste were made, and if pitch was being tested, five different pitches would be used. The human subject would take a sip of one of the solutions with no sound being apparent, then the pitch would play, and the human subject would take another sip of the same solution. He or she would then record if the certain pitch made the solution less bitter, acidic, sweet or salty, nothing changed, or more bitter, acidic, sweet or salty. This procedure was repeated for each of the five pitches, each of the four tastes, and then for volume and tempo sections of the experiment. After all the data was collected, conclusions were made. These conclusions would tie into the real world by determining what music certain restaurants should play to give the best results with their food. Depending on the type of food a restaurant serves, the music they play can affect taste.

SBS123: What Time of Day Do Teenagers' Cognitive Functions Work Best?

Most high schools in America start before eight o'clock in the morning, but science indicates that this may be counterproductive to learning. The purpose of my experiment is to find out what time of day teenagers' cognitive functions work best. To test this, I gave participants, one at a time, a 3-digit-by-3-digit multiplication test at three separate times of day, 7:45 AM, 11:45 AM, and 8 PM. While they took the test I timed them, and before the test I asked how many hours of sleep they got. After all ten participants had taken three tests each, I scored the tests and found that 8 PM is the time when teens' cognitive functions are working the best. Morning and midday showed almost the same average results, refuting my hypothesis that morning would be the worst time for cognitive activity.

SBS124: Improving Customer Service using AI

Please visit student's exhibit for abstract

SBS125: How can the Environment You are in Change Your Mood?

SAD is a disorder in where the weather can better or worsen your mood. Thise experiment's purpose is to research and have better knowledge about SAD. To do this I will have 10 participants do a survey based on how they feel and a description of the weather in their view, using this we can then categorize the information with key words. Experimentation is ongoing and results will be provided at the science fair.

SBS300: A Study on Gender Bias

Gender bias is often presented in verbal explanation and impacts gender equality. We see and hear gender bias almost everyday and wanted to bring awareness to gender bias. Our experiment will document the way people explain stereotypical gendered activities. This includes building with legos and using makeup. We will do this by recording their average word count, body language and how long it takes for people to explain these activities. This experiment will include 14 participants who will explain a stereotype activity to a male/female assistant. This experimentation is still ongoing and the results will be provided at the science fair.

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Biology (SBI)

SBI100: Salvia Divonorum and the Kappa Opioid Receptor

The kappa opioid receptor (KOR) is a G-coupled protein receptor responsible for the inhibition of pain, itch, and addiction. Although much is known about KOR, in the inhibition of pain, itch, and sensory integration, almost nothing is known about the role of KOR in mediating hallucinations. This research will explore KOR and its role mediating hallucinations induced by the active ingredient in the naturally occurring drug Salvia Divonorum, Salvinorin-A. This research will determine the most effective animal model to use in experiments that test how and why the kappa opioid receptor mediates these hallucinations. It will allow for the studying of and experimentation with KOR mediated Salvia induced hallucinations, and ultimately the development of a neural and cellular basis for the process by which KOR mediates hallucinations, which is not currently available. The process for this research is fivefold; four of these phases will involve a literature review that will explore the neurological and cellular process by which these hallucinations occur and the neuronal expression of KOR in different areas of the brain. The fifth phase will be experimental and will involve the utilization of the animal model that is determined to be most effective. The development of a neural basis that describes KOR mediated hallucinations will have important biomedical applications and will be a significant discovery in the field of neurobiology.

SBI101: Ants' Response to Color

The purpose of this project is to determine whether ants' behavior changes based on the color of an ant farm. It is extremely important to better understand how one of the most populous species on the planet sees and thinks. Two trials of 4 different colors and one trial of the control group were set up. The two trials included the colors yellow, purple, green, and red and the control group had no color. The second color trial included the same colors just in a different order. The measurements - number of tunnels, length of tunnels, and branches within each tunnel - were collected every few days. A non-quantitative piece of data collected was the grouping of the ants to see where the ants spent the most time. Data was collected for 6 weeks. Yellow and purple had the greatest number of tunnels, total length of tunnels, and branches compared to red and green. Green was the least popular in terms of tunnels. The ants primarily hung out in the yellow side and non-colored portions of the red/green ant farm. It is difficult to know exactly when the tunnels were created but it is clear that tunnel building slowed down over time. The hypothesis was not well supported since green, and purple were predicted to be the most popular colors. Purple was pretty popular in tunnel building but green was not popular at all. This data can be used to better our understanding of ants which can eventually be used to help us develop navigating tools for autonomous vehicles.

SBI102: Fluorescent Microscopy Analysis in Plasma Membrane Protein Trafficking Studies

The purpose of the research being conducted is to facilitate the use of Fluorescent Activated Protein (FAP) technology in yeast research, enable the further study of the alpha-arrestin regulation of key Plasma Membrane proteins, and gain more knowledge about the dysregulation of the Kir2.1 potassium channel. To perform this analysis, an array of integrating plasmids is created for the tagging of select plasma membrane proteins with FAP including two c-terminally tagged FAP plasmids and one n-terminally tagged FAP plasmid. C-terminally and n-terminally tagged refer to the placement of the FAP on the plasmid. The methods used to create these plasmids are Restriction Enzyme Cloning and Gibson Assembly. The newly constructed integrating plasmids are then chromosomally integrated into Ste3, a pheromone receptor, and Kir2.1 to study the protein trafficking in these systems. The data that will be collected is imaging of the Kir2.1 on the plasma membrane surface. We may also conduct spot assays to determine the sensitivity of select strains to potassium concentration and a western blot to determine changes in protein abundance as additional data. We anticipate that the results of our research will provide us more knowledge on the protein trafficking systems of Kir2.1 which work towards developing a better understanding of the diseases that arise from the errors in these systems.

SBI103: Frogs and pH-ungi: The Relationship between Aquatic Acidity and Pathogen Growth

The fungus Batrachochytrium dendrobatidis (Bd) has caused amphibian decline globally. As humans interact with the environment, factors influencing Bd growth change. I aim to better understand the interaction between Bd growth and aquatic acidity. Using a micro-plate I will grow Bd within 6 different pH solutions to determine the relationship between aquatic acidity and Bd growth. Previous research has shown Bd grows well around neutral pH's. By extending the range of pH's, I have the opportunity to discover Bd growth in non-neutral pH. With my research I can investigate how Bd functions within different aquatic acidity. This research will help inform future decisions to limit the lethality of Bd on amphibians.

SBI104: Competitive Fitness and Gene Evolution of C. Elegans

The purpose of this research is to determine if the meiotic mutation in the Caenorhabditis Elegan strain REC-1 plays a role in its competitive fitness against the wildtype N2 and mutated CEP-1 strain. The REC-1 mutation was discovered in 2015 and it is still unknown as to why the genome selected for this mutation, my research will determine if it was for the purpose of better competitive fitness. I will be competing the 3 different strains in 4 different combinations over the course of 6 months and will repeat the competitions 4 different times. The competitions are as follows, N2 v CEP-1, N2 v. REC-1, CEP-1 v. N2, and CEP-1 v. N2 v. REC-1. They will live on NGM agar-seeded plates with Escherichia coli strain OP50 incubated at 24° C and will grow until they reach their fourth generation. At the end of their competition, I will use gel electrophoresis and sequencing to genotype the worms on my plate and determine which strain won the competition. I hypothesize that out of the strains that competed with N2s, the N2s will win because they are healthy and nonmutated whereas in the CEP-1 v. REC-1 competition the REC-1 will win because their mutation will allow them to quickly produce and have healthier, longer-living progeny. After genotyping, I will see which strain had the most progeny on each plate and the most occurring strain will have won the competition. I hope my research helps to aid in the question asking why the genome selected for this REC-1 mutation and helps figure out why double-strand break meiotic mutations occur in C. Elegans.

SBI105: Somatosensory Synapse Analysis

On somatostatin cells, which are inhibitory neurons in the cerebral cortex of mice, it is understood that during the learning process, overall activity goes down. Therefore, excitation must be reduced and/or inhibition likely increases. Imaging and analyzing the protein constituents of inhibitory synapses can be done to explore this relationship during the learning process. Using confocal microscope images of immunolabelled brain tissue from trained and untrained mice, the cells and synapses help track patterns and changes over the learning process. Imaris Cell Imaging Software will be used to both reconstruct the cell objects to collect quantitative data about synapses, as well as analyze the images for overall observations about the synapses' physical components and quantity of synapses. Observing changes in morphology, synapse quantity, and physical components may show changes in synaptic connectivity and inhibition. Comparing these quantities over time will show how the learning process affects inhibition before or after training, as well as the protein constituents inside of the synapse. For example, a decrease of Gephyrin in inhibitory synapses labelled with VGAT is anticipated. Overall, this research will support continued efforts to understand the learning process of the brain, and how synaptic connectivity is changed with experience.

SBI106: Honey and tumors resulting from Agrobacterium tumefaciens

Agrobacterium tumefaciens is a bacteria that can cause crown galls. A crown gall is a tumor that forms inside of a plant. In an article published in Evidence-Based Complementary and Alternative Medicine, honey was studied and found to inhibit tumors in humans. The purpose of this study was to determine if it could inhibit tumors in plants. The plant that was tested was Phaseolus vulgaris. In the first treatment group, honey was rubbed onto the inoculation site and the resulting tumor. The second group was watered with heated honey water when the tumors had started to grow. All of the plants were inoculated with the bacterium. The hypothesis was that the honey water will help stunt the growth of the tumor more than rubbing the honey. This hypothesis was made because when honey is heated up, all of the nutrients have been released. The statistics showed that honey is not a consistently reliable treatment, but the data showed that, in some instances, the honey did inhibit tumors. ANOVA and T-tests which showed that this method will not always be 100% effective. My hypothesis was not supported by my statistics.

SBI107: Growing Lactuca sativa aquaponically

Traditional farming has detrimental effects on the environment such as deforestation, excess water use, fertilizer pollution, and greenhouse gas emissions. For years, scientists have been trying to find a solution to these problems. One of the newer solutions is aquaponics. Aquaponics is the growing of plants using fish and other aquatic organisms. The purpose of this experiment was to compare the mass of plants grown with aquaponics and plants grown in soil. To do this, Lactuca sativa seeds were planted in soil, and in an aquaponics system. The plan was to grow both sets of plants for five weeks but the aquaponic plants had to be terminated a week early due to root rot. The results showed that the plants grown in soil had significantly more mass than the aquaponics plants. This did not support the hypothesis that the aquaponics plants would have more mass. However, the data was most likely skewed due to the root rot so a second experiment is being conducted with improvements in hopes of getting results without the root rot as an affecting variable. There currently is no data for this experiment however results will be available at the time of the fair.

SBI108: Spirulina Powder and the Growth of Lactuca sativa

Lactuca sativa, otherwise known as buttercrunch lettuce, is a plant that requires iron in order to perform photosynthesis. This experiment involves the use of spirulina, a blue-green algae, that contains iron. This information led to a project that can determine if spirulina powder would help enhance the growth of a plant such as Lactuca sativa, and if so, what amount would be the most effective. Different amounts of spirulina powder were added to the four treatment groups. The control had an average growth length of two centimeters while the treatment groups did not grow. The treatment groups did not produce any Lactuca sativa due to the growth of mold. This experiment is now being repeated with a different method in order to collect data for PRSEF. There are now more seeds being planted per cup and spirulina is being mixed with the water when it is added to the soil instead of being placed on top of the soil.

SBI109: Environmental Effects on Mycelium Structure

Plastics take very long to degrade which leads to its ubiquity as a waste in our environment. Plastics break down into microplastics which can pose a greater threat because of their small nature and in some animals, it can clog digestive tracts which leads to death. Millions of animals die from plastics every year. Saprotrophic fungi are the world's natural decomposers. Mycelia are the roots of fungi composed of a network of hyphae that secrete enzymes that can break down polymers such as cellulose and lignin in substrates such as wood. Mycelium can bind to such substrates creating a new material of wood and mycelium. This mycelium material has the potential to replace plastic as a plastic substitute because of its cost efficiency and strength. The purpose of this research is to examine the environmental effects on the structure of mycelium material. What effects cause mycelium to have similar properties to that of plastic materials such as expanded polystyrene? Disadvantages of mycelium would be high humidity and mycelium's ability to absorb moisture. One aspect of this research is to determine if high temperatures will deactivate the mycelium, which would then prevent further absorption of moisture and subsequently increase the life of the material. Tensile strength and absorption of water are examples of data collected.

SBI110: Creating a Machine Learning Model of Orca Language

Orcinus orca (killer whales) exhibit complex calls. They last about a second. In a call, an orca typically uses multiple frequencies simultaneously, varies the frequencies, and varies their volumes. Behavior data is hard to obtain because orcas live underwater and travel quickly. Sound data is relatively easy to capture. As a science goal, we would like to know whether orca vocalizations constitute a semantic language. We do this by studying whether machine learning can predict behavior from vocalizations. Such prediction would also help scientific research and safety applications because one would like to predict behavior while only having to capture sound. A significant challenge in this process is lack of labeled data. We work with recent recordings of McMurdo Sound orcas [Wellard et al., 17 2020a] where each recording is labeled with the behaviors observed during the recording. This yields a dataset where sound segments%u2014continuous vocalizations that can be thought of as call sequences or more general structures%u2014within the recordings are labeled with superfluous behaviors. Despite that, with a careful combination of recent machine learning techniques, we achieve 96.4% classification accuracy. This suggests that orcas do use a semantic language. It is also promising for research and other applications.

SBI111: Germinating wild and cultivated tomatoes in salt water.

Wild tomatoes, native to Peru, Ecuador, Chile, and the Galapagos Islands, are more genetically diverse than the cultivated tomatoes that we grow and eat. Repeated droughts caused by global warming reduce the freshwater supply and increase the salinity of the soil. One possible solution to this problem is to breed salt resistant crops so that farmers can use sea water for irrigation. Wild tomatoes could be a source for salt resistant traits to be introduced into cultivated tomatoes. My question is, are wild tomatoes more salt tolerant than cultivated tomatoes during germination? Are there species of tomato that can be watered with sea water? To test this I germinated twelve species of wild tomatoes and 3 cultivated varieties in 0.01%, 0.05%, 0.1%, 0.2%, 0.3% salt. I counted how many of the seeds germinated after 5, 8, 12, and 14 days, and compared the germination rates to a no salt control. Two species (S. habrochaites and S. peruvianum) of wild tomato were more tolerant to salt during germination than cultivated tomatoes. One species, S. peruvianum, was able to germinate in 0.3% salt, which is the same concentration of salt as that of sea water. In conclusion, while some wild tomatoes are not as salt tolerant as cultivated tomatoes, two species of wild tomato have the potential to be a source for salt resistant traits.

SBI112: The Effect of Natural Deer Repellants on the Growth of Lettuce

Deer are a huge problem in Pennsylvania, therefore many people use deer repellents to help protect their plants from getting eaten. My experiment provides a way to show if the deer repellent, while keeping the deer away, is affecting the growth of the plant. To do this I randomly assigned 100 lettuce plants to one of 6 experimental groups treated with deer repellant (3 organic, 3 non-organic) or a control group. I measured and recorded the height of each plant every three days for 36 days. I compared the average maximum height to determine if there was a significant difference between each experimental group and the untreated lettuce. One of the deer repellents used was shown to seriously affect the growth of the lettuce, therefore rejecting my hypothesis that natural deer repellents don't affect the growth of plants. While my conclusion does not support my hypothesis, in my experiment if the deer repellent did not have an ingredient that killed the plant then it did not affect the growth.

SBI113: Impact of Environmental Change on Daphnia

Global warming has been deteriorating the biodiversity of ecosystems over the world. Because of its large influence on other organisms in the environment, the ability of daphnia to adapt to changing temperatures will be a key factor to maintain the biodiversity of freshwater ecosystems. This experiment inspected the influence of patterned temperature changes on daphnia magna. Heart rate, viability and body length was recorded after the exposure of 9 temperature patterns ranging 20°-29° C. Each pattern was devised to represent different phenomenons occurring in current environments such as heat waves. The Daphnia cultured in higher temperature tended to have a higher heart rate and low survival. This tendency did not change even when the temperature was lowered afterwards.

SBI114: Which type of DNA (mitochondrial or nuclear) degrades the least based on the environment it is placed in?

In forensic science recent advancements in the study of Mitochondrial DNA have resulted in a debate between which type of DNA (Nuclear or Mitochondrial DNA) is best to use in lab testing. One ay to determine that is to measure which type of DNA degrades the least in different environments based on the quality of PCR cycles and pixel analysis of gel electrophoresis images

SBI115: N%u2076-Methyladenosine RNA Post Transcriptional Modification in Hepatitis B Virus Infection

Please visit student's exhibit for abstract

SBI116: Novel GFP tested in saccharomyces cerevisiae.

Introduction: Green fluorescent protein (GFP), originally isolated from the jellyfish Aqueora victoria, is a ubiquitous molecular engineering tool used in biological research. GFP is used as a marker protein, important for tracking processes within cells. Therefore it is important to advance GFP effectiveness for a variety of research applications because improving GFP fluorescent intensity would increase the sensitivity of GFP-based assays. The goal of this study was to test if a 20 amino acid N%u2013terminal tag (580N) would increase the fluorescence intensity of a fluorescent protein in Saccharomyces cerevisiae compared to GFP without the tag. This unpublished 580N tag has shown to increase the fluorescence intensity of fluorescent proteins in several bacterial species, but has never been tested in a eukaryote. Therefore, we evaluated whether 580N could improve GFP function in an important yeast species. Method: Yeast in vivo homologous recombination was used with a plasmid and synthetic DNA to generate two plasmids. One had the mUkG1 gene and the other with mUkG1 fused to the 580N tag. Each expressed mUkG1 under the control of the strong ADH1 promoter. A vector control without mUkG1 was used as a negative control. These plasmids were moved into S. cerevisiae strain InvSc1. MUkG1 was picked for this project because it is one the brightest GFP's tested in yeast. Yeast plates without uracil were used to select for yeast colonies with the plasmid. Fluorescence was first measured with a fluorescent dissecting scope and a fluorometer and normalized by the optical density value (OD600). Data was analyzed with Prism software. Results: Based on both quantification methods, the plasmid with the 580N tag conferred less fluorescence than the plasmid with mUkG1 only. Conclusion: The 580N tag showed no increase in mUkG1 fluorescence intensity in S. cerevisiae; therefore, the null hypothesis is accepted.

SBI117: Does ethnicity affect the ability to taste PTC

The objective of this work is to determine whether ethnicity impacts the ability to perceive bitter taste. Bitter taste is mediated by a family of about 30 different types of receptors, which bind to about 500 different molecules. One of these receptors, the TAS2R38 gene, fairly strictly binds to the chemical group CN=S, which is contained in many thioureas, such as phenylthiocarbamide (PTC) and is widespread in many edible cruciferous vegetables. In a group of 60 subjects, the objective was to determine each participant's bitter taste sensitivity, and then analyze the data collected to determine whether ethnic groups within the participant pool displayed similarities. This was done by collecting phenotypical data through the usage of PTC and control strips, as well as amplifying the TAS2R38 gene using PCR. After amplification, the gene was cut using HaeIII, and the digested DNA was run through gel electrophoresis to visualize results. The phenotypical results indicated that ethnic groups presented similarly, and that moderate tasting was the most common. This aligned with the hypothesis that ethnic groups share propensities.

SBI118: Tracking Eye Movements in Excitebike

Please visit student's exhibit for abstract

SBI119: Sex-Based Differences in Environmental Regulation of Macrophage Mediated Cancer Immunity

Please visit student's exhibit for abstract

SBI120: The Effects Glucose has on Daphnia

When previous research has been conducted it has been shown that when sucrose, salt, or caffeine has been added to a daphnia it's heart rate dramatically increased. When conducting my own experiment, I came to a much more divergent conclusion. For my first trail I put one daphnia under a microscope and counted its heart rate for 20 seconds to get the control variable of the daphnia, then a solution of 10ml of water and .1 gram of sucrose was added to the daphnia. After letting it sit for 30 seconds, I again tracked its heart rate for another 20 seconds. I repeated this 3 more times and that concluded trail 1. I counted the heart rate of another daphnia for 20 seconds, to get the control, then I added a solution of .5 grams of sucrose and 10 ml of water to a daphnia then waited 30 seconds, then counted its heart rate for another 20 seconds. I repeated this 3 more times, and this was the conclusion of trail 2. I counted the heart rate of another daphnia to get the control then I added a solution of 10 ml of sucrose and 1. grams of sucrose. Then I waited for 30 seconds and counted the heart rate for 20 seconds. I conducted this 3 more times, and this was the end of trail 3. My research concluded that trail 1 had the greatest change in heart with an average of 6.75 beat decrease in heart rate after the sucrose solution was added.

SBI121: A Novel Autophagy Regulatory Protein ATG12-187 and Chloroquine Treatment Synergistically Induce Apoptotic Cancer Cell Death

Chloroquine (CQ) is an anti-malarial drug used to treat autoimmune diseases, including rheumatoid arthritis and systemic lupus erythematosus. My previous study revealed new aspects of chloroquine-induced damage to crucial organelles, including lysosomes and mitochondria. In response to the cellular injury by chloroquine, the cell initiates a protective autophagy pathway to quarantine the damaged organelles to escape cell death (PRSEF 2021 Activation of Novel Autophagy Pathways to Protect Hepatocyte Injury by Chloroquine, see the attached abstract). My more recent finding of a novel autophagy regulatory protein, ATG12-187, can inhibit the autophagy pathway by endolysosomal degradation of autophagy key proteins ATG3 and ATG5 (PRSEF 2022 A Novel Autophagy-related Gene Regulates Autophagy Through Endolysosomal Pathway. See the attached abstract.). In the current study I hypothesized that the blockage of the autophagy pathway by ATG12-187 in cancer cells paired with chloroquine treatment induce unprotected lysosomal and mitochondrial damage, leading to apoptotic cancer cell death. I demonstrated this hypothesis in several human cancer cells, where the combination treatment of cancer cells with ATG12-187 and CQ trigger significant cancer cell death through the caspase-9 and caspase-3/7 apoptotic cell death pathway due to cancer cell loss of the autophagy protective pathway by ATG12-187. Given that chloroquine has been used for cancer therapy with limited efficacy, the current concept-proof study provides a new avenue to treat cancer using my recent novel discoveries. Key Words: chloroquine, autophagy, ATG12-187, cancer cell death, cancer therapy

SBI122: Design of novel CB2 allosteric modulators by molecular modeling and bio-validations

Cannabinoid receptor types 1&2 are very common receptors that mediate the central nervous system (CNS) and peripheral immune system. Specifically, CB1 is much more common and mainly mediates the CNS while CB2 is less common and mostly mediates the peripheral immune system. Since CB1 is majorly expressed in the CNS, activation of CB1 may cause psychosis and panic, while inhibition may cause depression and anxiety. Therefore, allosteric modulators targeting CB2 are effective while avoiding the negative psychotropic effects. Many PAMs and NAMs of CB1 have already been discovered. However, allosteric modulators targeting CB2 are much more scarce. The Positive Allosteric Modulator (PAM) ZCZ011 and Negative Allosteric Modulator (NAM) ORG27569 from the CB1 receptor gave us a framework to discover CB2 PAMs and NAMs as the structures of CB1 and CB2 are very similar. Thus, I compared quantitative structure activity relationships between the effective ligands of CB1 (ORG27569 and ZCZ011) and used these relationships to modify the ligands to better fit the binding sites of CB2. MCCS was further used to calculate the normalized free energy of each ligand and the residue energy contribution. The experimental results and bio-validations using Molecular Dynamics simulations (MDS) are not currently available but will be ready on fair day. These results are crucial as allosteric modulators of CB2 allow us to control the negative neurological and psychological effects of cannabis, a drug that is becoming increasingly popular and widespread.

SBI123: GMO Contamination in Common Foods

A Genetically Modified Organism(GMO) is a plant, animal, or organism whose genetic makeup has been altered using laboratory techniques through genetic engineering. GMO's are then involved in combining the genes of various organisms that are not derived naturally or through traditional crossbreeding methods. My study will determine the validity of the controversies GMO's cause of whether such food should be labeled along with the objectivity of GMO's effect on human health with scientific evidence. My procedure is as follows: obtain positive and negative controls of GMO's, isolated DNA from various foods, Centrifugation techniques, Polymerase Chain Reaction of DNA, and Agarose Gel Electrophoresis. The results from the Gel Electrophoresis will indicate which foods contain GMO's and will verify if the food companies are transparent in their product management.

SBI124: The Effects of Metal Catalysts on Water Electrolysis

Hydrogen energy is becoming an increasingly popular source of sustainable/eco-friendly energy. Natural gas reformation creates 95% of industry hydrogen, but this process is not sustainable. Water electrolysis however is more eco-friendly and combined with solar energy leaves no carbon footprint. It is not the industry standard due to its lower efficiency; catalysts can fix this. This experiment uses electrochemical deposition of cheap and earth-abundant NiOH as a catalyst for water electrolysis, showing that 1) electroplating can be used instead of expensive nano-particle electrodes to add a catalyst, and 2) water electrolysis can affordably be made more efficient to encourage the use of hydrogen energy.

SBI125: Analysis of Network Topology for Identifying Drug-Resistance Mechanisms

Drug resistance is one of the major clinical problems that limit cancer therapies by targeted drugs. The purpose of this project is to investigate the influence of intracellular network topology on drug resistance mechanisms. Our hypothesis is that a model that accurately captures the topology and timing of intertwined feedback and feedforward loops can lead to explanations of biological pathway behavior and drug-resistance mechanisms. To test this hypothesis, an example of Ras protein signaling is used. First, several previously created network models of Ras signaling are collected, and differences in feedback loops within those models are determined. Next, model simulation and analysis tools are used to comprehensively explore behavior of these models. These computational steps output a set of textual and Excel files with data representing element states in time. The obtained data will be used to determine key differences in simulation results across models and their correlation to network topology. An in-depth investigation of the interplay between network topology and timing, and their relationship to drug-resistance mechanisms will be conducted. The hypothesis is confirmed if there is a proof of correlation between network topology, feedback and feedforward loops in a model, and the drug resistance marker activity.

SBI126: Snakes and the Unknown

Please visit student's exhibit for abstract

SBI127: Studying the Effects of Mesothelial to Mesenchymal Transition on High-Grade Serous Ovarian Carcinoma Metastasis (2022)

Please visit student's exhibit for abstract

SBI128: Efficient Biofuel Generation of Plants Using Enzymes

The purpose of this experiment is to test the Efficiency of Biofuel Generation of Plants Using Enzymes. The question being asked is at what concentration of glucose will yeast fermentation rates be the most efficient in order to produce Ethanol through fermentation? Plant-derived fuels are a new beneficial way to improve sustainability. Hopefully this will help someday cut down our dependency on non-renewable carbon-based fuels, such as gasoline. Methods for researching this topic includes studying the environmental impacts of Ethanol, how it is produced, the process of enzyme digestion and the process of yeast alcohol fermentation. Using the research collected, it is determined that the resources needed include, cellulase, cellulose, pH 5 buffer solution, dry yeast, glucose and materials such as flasks, pipettes, graduated tubes etc. The data will be collected by analyzing the standard curve of the yeast fermentation and observing what concentration of glucose, yeast fermentation rates will be most efficient in order to produce ethanol. It will be recorded on paper measuring the fermentation rate, then the data will be transformed into a graph and table to clearly show the data. It is hypothesized that the conclusion will result in the yeast fermentation rates being most efficient at the lowest concentration of glucose because it will have enough energy to efficiently produce ethanol. This project is beneficial for our environment as biofuel such as ethanol is produced from plants with high sugar content that are edible, such as corn and sugarcane. Many have hopes that this can be the new future of staying environmentally friendly.

SBI129: Danio rerio Fin Regeneration Post-exposure to Red Dye

In prior years, I have conducted experiments relating to red dye and its various harms for humans. Last year I conducted an experiment that observed the effects that the dye had on animals, in this case, zebrafish. It turned out that red dye can have significant effects on the development of a zebrafish. To further elaborate my discoveries of the harms of red dye, I wanted to see if red dye can also affect the regeneration of a zebrafish's fins. Zebrafish have a quick regeneration process that allows them to grow back their fins in no time. The problem is will the red dye affect the fin regeneration of the zebrafish? The hypothesis is The scientist believes that the red dye will affect the regeneration of the zebrafish's fin. First, I will collect the embryos and place them in their designated dye concentrates (or control). After 5 days, the fish will be taken out and each tail will individually be cut. The fish will then be left in a filter tank with water. They will be measured every three days to track if there is any growth. Data will be collected and analyzed. There are very few risks that come with this experiment. The only risks that should be accounted for is the harm of red dye or the scalpel. The red dye will be properly disposed of in a container. The scalpel head will also be properly disposed of after use. The data will be collected over three-day intervals. Each set of measurements will be compared to the prior measurements collected and the original measurements after the cut.

SBI130: Chemicals in Water and How They Affect Plant Growth

Water is a necessity in our lives, and if there are chemicals within drinking water, our health could be affected. My experiment tests water for chemicals and then uses those same waters to grow plants. This determines if the chemicals within these waters affect health. The hypothesis of this experiment is that sparkling water, Perrier, would stunt seed growth and have the most chemicals. Some of the procedures being used include testing the water, planting ryegrass seeds, and watering seeds every other day for twelve days. The results showed that the hypothesis was supported. Perrier had high levels of harmful chemicals, and stunted plant growth, while the retention pond water had high amounts of carbonate as well as alkalinity, creating a lesser quantity of sprouts.

SBI131: Investigating Mesothelial to Mesenchymal Transition in Invasive Lobular Cancer Metastasis

Intro: We want to investigate why ILC, characterized by a lack of E-cadherin, has a unique metastatic pattern. The unique pattern of ILC is that it tends to metastasize to the ovaries, leptomeninges, GI organs, and peritoneum. Mesothelial cells originate from the mesoderm but show characteristics analogous to both mesenchymal and epithelial cells. Studies suggest that mesothelial cells can undergo phenotypic changes following activation of an epithelial state to a more mesenchymal morphology. This process has been coined as Mesothelial-Mesenchymal Transition (MMT). MMT is a dynamic cellular process that occurs during development, tissue repair, fibrosis, and metastasis. MMT is characterized by the gradual loss of cell-cell adhesion networks through the expression of adherence and tight junctional proteins; E-cadherin (Cdh1) and ZO1 respectively. We want to see if ILC or IDC cells induce MMT; MMT has been reported to promote ovarian cancer metastasis. We hypothesize that MMT promotes ILC metastasis and IDC cells to exert no reaction. Methods: To study this, we will treat mesothelial cells with conditioned media from ILC cells and IDC cells lines. We will look at morphology of the cells and perform western blots for MMT markers such as E-cadherin, mesothelin, vimentin, WT-1, N-cadherin, alpha-SMA, and beta- actin. Results: All the breast cancer conditioned media increased E-cadherin and A-SMA. There are no major differences among mesenchymal or mesothelial markers between ILC and IDC cell lines; it is unclear whether MMT is occurring more from ILC or IDC conditioned media. We also performed a trans-well migration assay which showed that ILC cells had more migration towards mesothelial cells than IDC cells. Conclusions: It is unclear whether MMT occurs more with ILC or IDC cell lines, however ILC cells show more migration toward mesothelial cells. Future Directions: Future directions include testing additional mesenchymal markers such as fibronectin, MMP2, and TGFB-1.

SBI132: Supplemental Feeders for Migratory Birds

Evening Grosbeak, Hesperiphona Vespertina, are an irruptive species of migratory bird, meaning their migration to other areas is based on food supply. Studies show that the Evening Grosbeak species has been experiencing a population decline, dropping by 92% since 1970. The purpose of this project is to provide Evening Grosbeak with a supplemental food source during the colder months in an attempt to prevent any further population decline. For this project, five platform bird feeders spaced four feet apart, were set up using shepherd hooks with game cameras. Each feeder contained one of five different types of food that Evening Grosbeak have been known to eat, including safflower seed, black oil sunflower seed, and three other varieties of commercial food mixes. One cup of each food variety was added to the respective feeders for three consecutive days, after which the cameras were checked for the type of birds to have visited each feeder. The amount of food remaining was measured to determine which was preferred by the Evening Grosbeak that visited each feeder. This procedure was repeated for five trials. While experimentation is still in progress, it is hypothesized that the Evening Grosbeak will feed from the commercial food mixes more than the other food varieties.

SBI133: Tonicity of Sports Drinks

Tonicity refers to the relative concentration of solute particles in a solution. The tonicity of ingested or infused liquids can potentially produce adverse effects on animals, including humans. Sports drinks are marketed as a means of replacing essential electrolytes and fuels in the body of a physically stressed individual. Dialysis tubing will be used to determine the relative tonicity of various sports drinks. A standard curve of sucrose solutions will be used as a reference.

SBI134: Ethinyl Estradiol Effects on Zebra Fish Development

Many people have experimented with Ethinyl Estradiol and its effects on the environment. This chemical is also known as EE2 and is a synthetic estrogen found in a significant number of oral contraceptives (Wershler). While this chemical starts within a pill, after consumption it makes its way into water ways. Some of the specific states it has been found in include Texas, Kentucky, Pennsylvania, and California (EWG). EE2 is shown to cause serious effects on the wildlife in these environments, including intersex (Jobbing and Owen), weaker reproduction, and imbalanced sex ratios (Foster and Brown). In this experiment I will be focused on imbalanced sex ratios. The fish will start their development in a water solution with different concentrations of EE2. Then, after 7 days, they will be transferred to regular pond water, where they will be observed, monitored, and gendered to see the effects EE2 has on their development.

SBI135: Improving Cockroach Memory

Rationale Memory has been interesting to me. I wondered whether turmeric which is thought of to be a medicinal herb to positively impact the rate of learning and how efficient memory is. Based off my research, I found that memory may be impacted by Turmeric. I also found that Eulaberus Posticus may be a model for testing on learning and memory. I decided to test the effects of Turmeric on Eulaberus Posticus. Procedure Eulaberus Posticus were ordered. The Eulaberus Posticus will be grouped into male and female. They will be placed on a plexi-glass tube to train them to travel a certain route with a reward of carrots for ten days. This will be known as the training stage. After the ten days, the Eulaberus Posticus will be placed on a double sided T-maze with carrots in a specific area following the same route as the training stage. They will be timed to see how long they complete the maze for another ten days for the memory test stage. Observations will be taken daily. Data Observations are how long it takes one Eulaberus Posticus to finish the memory maze. Observations are also how long the cockroach lives. Conclusion Results will be available on fair day

SBI136: Time Flies

Please visit student's exhibit for abstract

SBI300: Towards Explainable Pooling of CAR T cells

CAR T cell-driven therapies are a promising new cancer treatment approach, however, issues with persistence, resistance, and strong side effects, have prevented these therapies from broader use, especially in solid tumors. Our hypothesis is that by explaining biological mechanisms that have led to recent machine learning-driven CAR T cell designs, more effective therapies can be obtained. To support the hypothesis, models relevant for CAR T cell function are obtained. Next, several predictions of relationships between CAR T cell design and cellular processes are identified in recent publications. Additionally, the supplementary data provided with these publications will be used. The pathway networks and the connectivity between receptor domains and cell process markers will be investigated. Tools that automatically extract knowledge from literature will be used to inform the analysis and to identify inconsistencies and gaps in knowledge. To test the hypothesis, knowledge-guided explanations of computationally suggested T cell designs will be determined and will be examined to identify conflicts between knowledge and data. This project will provide a novel method for combining knowledge and data when designing CAR T cells and mechanistic explanations of recently proposed designs.

SBI301: The Effect of Sugars on Algae Photosynthesis

Algae provides a source of alternative fuel, therefore finding the best way to enhance algae growth would be beneficial as it would create more sustainable fueling solutions. This project aims to determine which sugars, glucose, fructose, or sucrose, increase algae growth without the presence of photosynthesis. Different types of sugars will be fed to Scenedesmus algae with the idea of enhancing growth. A pH indicator will provide evidence of multiplication rates and biomass processing speed as well as an indication of photosynthesis. Data will be collected and both charts, graphs, a 3D pie column will display results. This experiment is ongoing and results will be available on fair day.

Pittsburgh Regional SCIENCE & ENGINEERING Fair
Powered by CARNEGIE SCIENCE CENTER

84th Pittsburgh Regional Science & Engineering Fair

Senior Division

Chemistry (SCH)

Student Project Abstracts

March 29, 2023

Notes to Judges

Students prepare Abstracts limited to 100 words that include the following:

- Purpose of the experiment
- Procedures used
- Data
- Conclusions
- Possible research applications
- Minimal reference to previous work
- For continuation projects, the abstract should focus on work done since the last PRSEF
- Should not include: a) acknowledgments, or b) work or procedures done by the mentor

Many students continue their research after the Abstract is submitted, and therefore the Abstract may not fully represent the Project.

Abstracts are available to the Judges prior to the Science Fair as an aid in pre-screening the Projects. Judging is to be based on the actual Project as presented by the student.

Project Numbers are assigned as XYYABC

- X: S – Senior Division (9th through 12th grade)
- YY: Category Name
  - BS – Behavioral and Social Science
  - BI – Biology
  - CH – Chemistry
  - CM – Computer Science and Math
  - EE – Earth and Environment
  - ER – Engineering/Robotics
  - MH – Medicine/Health/Microbiology
  - PA – Physics and Astronomy
- ABC: Project number
  - 1xx or 2xx – Individual student projects
  - 3xx – Team projects (2 or 3 students)

Chemistry (SCH)

SCH100: Separating Enantiomers in a Racemic Mixture

The purpose of this research was to determine if enantioselectivity can be achieved using magnetism through the crystallization process. To examine this a magnet was submerged in a racemic mixture. The temperature was raised and then cooled to produce crystallization. Sample crystal specimens were collected from both the North and South surfaces of the magnet. The Circular Dichroism spectra were measured and examined in order to determine the chirality of the crystals. Results should demonstrate that this process can demonstrate enantioselectivity and preliminary results have supported this hypothesis. The method should provide an alternative way of accurately and efficiently separating enantiomers from a racemic mixture.

SCH101: Fire-ball

Around 50% of today's population consume protein bars. While sport athletes and bodybuilders consume the most amount of protein bars, students, travelers and people on a weight loss program also consume protein bars quite often. Protein bars are used everyday to help regain the energy lost after physical activity. How much energy do these bars actually give off? In this experiment, 4 brands of protein bars with different amounts of protein will be tested to see which bar gives off the most energy depending on the amount of protein each bar contains.

SCH102: Endocrine Disruption from Menstrual Products

The intent of this project is to bring awareness to the possibility of endocrine disruptors, specifically phthalates, within menstrual product applicators. It is hypothesized that the more expensive the menstrual product is, the less presence of phthalates there will be in the applicator. Also, the presence of eco-friendly advertising will also show a lesser amount of phthalates present in the applicator of the product. The procedure done was submerging 5 different tampon applicators in hexane, plus one extra beaker for a control variable. After letting the applicators soak, they were inserted into vials. These vials were then investigated by using gas chromatography mass spectrometry. Experimentation is still continuing and the results will be available on the day of the fair.

SCH103: Turning Plants into Biofuel

Our modern world runs on gasoline. However, the burning of gasoline emits harsh chemicals in the form of BTEX compounds into the atmosphere which, in turn, contributes to air and environmental pollution. My project seeks to prove that three readily-available environmental sources can be used to develop a sustainable, environmentally-friendly, and cost-effective alternative to gasoline. Three sources%u2014leaves, sticks, and grass%u2014will go through three processes%u2014chemical decomposition, fermentation, and thermal decomposition%u2014and ultimately yield biodiesel. My project hypothosizes that this experiment will yield a small amount of gas when conducted properly. Once I collect this gas, I will then collect and analyze the data that results from burning the collected gas. The resulting data can be used to further determine the factors that will aid in the large-scale production of clean, plant-based biofuel. Currently, no results are available as my experiment is still in progress, but results will be ready for review by the day of the fair.

SCH104: Chromatography in Forensics

Paper chromatography is specifically used for substances on paper. That is used in handwriting analysis. The intent of this experiment is to find the best solvent for breaking up the ink which is on the paper by using paper chromatography. Many types of pens and markers are used for this project to show the diversity of variant pens. No data were collected because the experimentation continues, and results will be available on a fair day.

SCH105: Most effective solution for getting acrylic paint out of carpet

The purpose of this experiment is to find the best and possibly cheapest solution to get acrylic paint out of carpet. The idea for this project is a result of having spilled acrylic paint on the bedroom carpet and a need to find a solution that is an effective cleaner as well as cost effective. The experiment was conducted by applying acrylic paint to carpet remnants in order to test various carpet cleaning solutions. Four sample solutions were tested including 2 store brands and 2 homemade solutions. Samples were applied to the carpet remnants after the paint dried to determine which, if any, of the cleaning solutions would remove the dried acrylic paint. I expect the store brand solutions to have the best results because of the chemicals they contain. Experimentation is still in progress with results to be available at time of presentation.

SCH106: Photopolymerized Superabsorbent Polymers Prepared from Bio-resources

Previous reports illustrate the feasibility of preparing superabsorbent polymers through a slow-pace and high-energy thermal polymerization process that utilizes petroleum-based monomers. Bio-monomers, such as Itaconic acid (IA), have been emerging due to their sustainability in response to recent climate change and environmental issues. This project explores the feasibility of superabsorbent polymer preparation through the superfast photopolymerization of bio-monomers such as IA. To maximize IA content in the final product, the solubility of solid IA in liquid dimethylacrylamide was examined. It was found that a clear monomer solution could be formed with an IA concentration as high as 33% by weight. Hydrophilic monomers N, N-dimethylacrylamide and 2-hydroxyethyl methacrylate, and bio-monomer IA were photopolymerized under ambient conditions utilizing phenylbis(2,4,6-trimethylbenzoyl)phosphine oxide as a photoinitiator in approximately one minute. Solid polymer beads have been prepared from different ratios of monomers, and their water absorbance was evaluated to confirm successful polymerization. The photopolymerization process and final polymers were characterized with Fourier-Transform Infrared Spectroscopy (FTIR), and Gas chromatography to further confirm successful polymerization. Polymer beads prepared with the super-fast photopolymerization technology in this study can absorb up to 356 times water of their dry weight. Moreover, the superabsorbent beads absorb much more water at high temperatures.

SCH107: Energy Storage Utilizing Electrolysis

While renewable energy sources solve the major problems associated with fossil fuels, there is one major issue with renewables: their intermittency in energy production. If the world is to depend on renewable energy, vast amounts of energy storage must be made available when renewables aren't producing electricity. A promising means of energy storage is the electrolysis of water. This process starts by using excess renewable energy during times of high production to perform electrolysis. This reaction splits the H2O into hydrogen and oxygen, and the hydrogen is then stored in tanks until the energy is needed. To recover the electricity, the hydrogen is run through a fuel cell, generating electricity. The goal of my experiment was to find the efficiency of this process and to compare it to different methods of energy storage. I started by finding the efficiency of an electrolysis device. To do this, I measured the number of joules put into the system through an electrical current. This was then compared to the number of joules contained in the hydrogen that was produced, with a calculated efficiency of 75%. I then tested how to store the hydrogen. I forced compressed hydrogen into a container, and I measured the pressure over time. There was only a slight reduction in pressure, showing the viability of energy storage. The efficiency of electrolysis and the ability to store hydrogen over long periods of time show that energy storage utilizing electrolysis is a practical option.

SCH108: Causes of Vitamin Deficiency

Food is one of the three basic elements that contribute towards a human's survival/health, and different vitamins are in different foods. A lack of certain ones can lead to a deficiency of certain vitamins, and more specifically, vitamin C. A deficiency of vitamin C can weaken or slow down the formation, growth, and repair of bone, skin, connective tissue, maintains healthy gums and teeth, helps the body absorb iron (needed to make red blood cells), helps burns and wounds heal, and is essential for the normal function of blood vessels. In extreme cases, vitamin C deficiency can lead to scurvy, a serious disease that can even be fatal. It can be as common as a high of 73.9% north India, a developing country (based on people 60 years old and older), and is rarer in developed countries but still affects more than 1 out of 20 people. Due to the fact that humans cannot make vitamin C or store it in large amounts, it must be consumed regularly to prevent deficiency, ideally through fresh fruits and vegetables, but many around the world in various living conditions cook, or atleast boil, the fresh foods in water to get rid of germs. This project will test how cooking time (boiling) will affect the vitamin C concentration in a bell pepper, a very common vegetable eaten across the world. This experiment as of now is still continuing, but the results will be available on fair day.

SCH109: Optimizing the Fuel to Oxidizer Ratio in Model Rocket Engines

Various ratios of oxidizer and fuel in solid rocket motors are tested to determine which produces the greatest total impulse. These rocket motors are produced by mixing potassium chlorate and liquid sorbitol and then pouring that mixture into a PVC tube. These rockets are made at different ratios of oxidizer to fuel by mass.Thrust over time data is collected for each rocket motor. To record the thrust of a motor, a test stand is used. Once the Test stand is powered it will automatically begin recording data, and a few seconds later the rocket will be ignited. After 200 seconds all data will be stored to a micro SD. Using this data a graph of thrust over time is made and the impulse of the motor is determined. A higher percent composition of oxidizer increases the rate that the fuel reacts and therefore decreases the burn time. Rocket motors with higher concentrations of oxidizer also have a greater maximum thrust. Data on the impulse of rockets will be presented at the day of the fair.

SCH110: Food vs. Rust: The Effects of Antioxidant High Foods on Rust

Please visit student's exhibit for abstract

SCH111: Food and Drink's affect on Daphnia Magna Heart Rate

The purpose of this experiment is to figure out what foods and drinks raise daphnia magna heart rate. In doing this, it will be found what foods raise the heart rate of a human through comparative anatomy and physiology. It was hypothesized that drinks higher in sugar and caffeine will raise heart rate and foods high in spices will raise heart rate. To perform this experiment, spices will be mixed with water and drinks will be placed on a slide with the daphnia and, looking through a microscope, the heart rate for one minute will be calculated. Final results will be available at the fair.

SCH112: Testing Fingerprint Composition Over Time

My project is an attempt to determine if forensic fingerprint testing is viable to use in court when the fingerprint is taken well after the crime was committed. My project will involve determining if the success rate of identification drops as the natural oils found from fingerprints slowly deteriorates over time. I will be using ceramic tile, wood, glass pane, and painted drywall, to test the fingerprint decomposition on these different types of materials over a two month period. The goal of this project is to stop these false convictions from occurring by being able to say depending on the time a specific fingerprint was made if it can be used as credible evidence. A basis of reference is that fingerprints are composed of multiple oils that are naturally produced by a person's body. I am intrigued by this idea because of the various cases I have read where people are falsely accused of criminal acts (typically murders or thefts). It is generally accepted that fingerprints can be used as valid evidence in court, although, in cases such as a lawyer, Brandon Mayfield, he was falsely convicted of the Madrid train bombing in 2004 because of false fingerprinting conviction (A Review of the FBI's Handling of the Brandon Mayfield Case (Unclassified and Redacted)). Also the case of Lana Canen, who was wrongly convicted in 2005 of a robbery and murder because of falsely matched fingerprints (Lana Canen - National Registry of Exonerations). As is evident through the cases mentioned above, this is a concerning issue that causes innocent people to be incarcerated for no reason. The goal of my project is to better understand the deterioration of fingerprinting in an effort to stop innocent jailing from happening. Testing is still in progress and results will be available at the science fair.

SCH113: Drinking Water Quality

The purpose of this experiment is to observe the difference between tap water, filtered, and boiled water to determine if the use of a filter/boiler is necessary. Many people drink from the faucet as it is both cheap and convenient, but should you invest in a boiler or a filter instead? There are many things in water that are harmful for people and putting it through a filter/boiler could save lives. The tap water, filtered, and boiled water will be ran through a series of tests done in random orders 3 times a day at the same time for 3 days to check the ph level, copper and other elements, and bacteria. The average of the results of the testing will be compared to each other and the EPA standards to see if there is a significant difference between them. As of right now, data is still being collected and results will be done by fair day. The findings in this experiment will help many people determine the necessity of having to own a filter or boiler. This is a big step in health as water is essential and clean water is harder to find now than ever from all the chemicals and pollute.

SCH114: Determining Iron Content in Foods Using Spectroscopy

For this experiment I broke down spinach and cheerios in order to see how much iron they produce. I choose this experiment because two years ago I become gluten free causing me to become anemic. I wanted to find food that would help me naturally increase my iron levels. Using a spectrophotometer I was able to develop a graphing system in order to see where the spinach (boiled and grinded) and cheerios burnt fell in relation to how much iron they produced.

SCH115: Impact of the Three Rivers in Pittsburgh on Human DNA Degradation Over Time

After a homicide has been committed, investigators can use DNA evidence from the scene in order to create a short tandem repeat profile and identify the perpetrator (Nwawuba, 2020). DNA evidence has become increasingly useful in the field of forensics due to advancements in technology capable of identifying suspects. However, this DNA can only be utilized if it is intact (Crouse, 2019). For homicides with victims found in water environments, pH level can contribute to DNA degradation, leading the researcher to question how water quality in different rivers in the Pittsburgh area degrade DNA over time. These results will allow investigators to determine if samples that have been collected from the bodies of water tested or similar bodies of water would be useful in forensic genetic genealogy. pH will be analyzed from water samples taken from various rivers in the Pittsburgh area. DNA will be extracted from cheek cells using a centrifuge, extraction solution, and incubation. The DNA will then be exposed to water from each of the rivers being tested and to a control group. To measure degradation, the researcher will conduct agarose gel electrophoresis and quantify degradation by how far the sample runs down the gel, since more fragmented pieces of DNA travel further. Data will be analyzed using a t-test to determine the strength of the correlation between river and DNA degradation, and the researcher will calculate a rate of degradation for each river. This allows further implications including the rate of decomposition in each river or similar rivers. Data collection is ongoing and final results will be shared on the day of the PRSEF competition.

SCH116: What Works Best for Red Stain Removal?

What are the most effective ways to remove red stains? Stains are an everyday problem that can be annoying if not dealt with properly. For each of the different condiments, ketchup, tomato sauce, and sriracha I cut up pieces of clothing and put 1 ml of the condiments on the cut up shirt. Then they sat for five minutes and were all tested to see what would take out stains the best. They were all tested with water, vinegar and baking soda, dish soap, Oxi clean and bleach. The Bleach worked the best, removing most of the stain and then the dish soap came in second, also removing a good amount of color. The experiment was created to test the easiest way to remove red colored stains on white clothes.

Pittsburgh Regional SCIENCE & ENGINEERING Fair
Powered by CARNEGIE SCIENCE CENTER

84th Pittsburgh Regional Science & Engineering Fair

Senior Division

Computer Science / Math (SCM)

Student Project Abstracts

March 29, 2023

Notes to Judges

Students prepare Abstracts limited to 100 words that include the following:

- Purpose of the experiment
- Procedures used
- Data
- Conclusions
- Possible research applications
- Minimal reference to previous work
- For continuation projects, the abstract should focus on work done since the last PRSEF
- Should not include: a) acknowledgments, or b) work or procedures done by the mentor

Many students continue their research after the Abstract is submitted, and therefore the Abstract may not fully represent the Project.

Abstracts are available to the Judges prior to the Science Fair as an aid in pre-screening the Projects. Judging is to be based on the actual Project as presented by the student.

Project Numbers are assigned as XYYABC

- X: S – Senior Division (9th through 12th grade)
- YY: Category Name
  - BS – Behavioral and Social Science
  - BI – Biology
  - CH – Chemistry
  - CM – Computer Science and Math
  - EE – Earth and Environment
  - ER – Engineering/Robotics
  - MH – Medicine/Health/Microbiology
  - PA – Physics and Astronomy
- ABC: Project number
  - 1xx or 2xx – Individual student projects
  - 3xx – Team projects (2 or 3 students)

Computer Science / Math (SCM)

SCM100: Diagnosis of Neurological Diseases using Classification Methods

This project will use statistical classification methods to diagnose neurological diseases such as Parkinson's and Alzheimer's. This project is necessary as most neurological diseases exhibit similar symptoms, making diagnosis by a clinician or person extremely difficult. This warrants the use of more specific methods which have a precision that is unrivaled by humans. This project will use data, including biomarkers and population characteristics for people with neurological diseases. Several classification methods will be used to analyze this problem such as SVM (Support Vector Machines), Random Forests, and more. Only a computer with commonly used software (Excel and R) and specific datasets will be necessary for this project. The anticipated results will be the classification accuracy of the various models and the types of relationships the analysis reveals between the input data (biomarkers and population characteristics) and the neurological diseases themselves. Some possible difficulties may arise from implementing the analysis properly, developing clear conclusions from the results, and adjusting the analysis properly to improve the classification accuracy. The ideal conclusions of this project will be a clear victor amongst the different models in terms of classification accuracy, and either the confirmation or addition of certain relationships between biomarkers and neurological diseases. This project has broad implications to curing neurological diseases as a dataset with the right inputs could help researchers establish a causing factor for these diseases which is extremely helpful in creating a cure.

SCM101: Finding JavaScript Vulnerabilities with Concolic Execution on Quivers

Cybersecurity is a major global issue, and at the core of large-scale attacks are small vulnerabilities lying undetected in applications and services. Much work has been done to develop automated vulnerability detection systems, and symbolic execution is a powerful approach. In symbolic execution, input variables are left as special symbolic values, and operations on symbolic variables build up a trace describing variables as a function of the inputs. Upon reaching an error, a Satisfiability Modulo Theories (SMT) solver is then invoked to solve for an input that satisfies all of the constraints required to reach the error. However, the most popular programming language today, JavaScript, has very few symbolic execution tools. This is largely because JavaScript is event-based. Code is organized into small procedures, called callbacks, which are then bound to certain events. This paradigm has proved very difficult to adapt symbolic execution to, as there exists both the space of possible paths that the program can walk through as well as the space of possible events that can be triggered, with only the former being directly encoded in code. I will develop a symbolic execution engine for JavaScript based off of representing event-based programs as quivers. These consist of nodes (representing callbacks) and a set of directed edges between them. Edges denote the inferred constraints under which the program will transition from one callback to another. The constraints required for a specific callback to fail can be derived once, and then propagated backwards until either deemed unsatisfiable in context or reachable from the start. These constraints will involve the specifics of the execution that generated them, most of which are not actually necessary. Thus, the constraint propagation process can guide the generation of new inputs to determine what constraints matter, in service of actually finding paths to vulnerabilities.

SCM102: Can AI Recognize Unseen Images?: Mitigating the Impact of Out-of-Distribution Examples for Colorectal Cancer Detection

In the real world, neural networks often come across objects that they weren't trained to recognize, or out-of-distribution (OOD) objects. Networks tend to very confidently misclassify these OOD objects which can be fatal in high-risk applications such as medical diagnosis and self-driving cars. This project aims to develop an algorithm capable of appropriately recognizing OOD objects. The algorithm will be based on the PathMNIST dataset which contains images depicting 9 stages of colorectal cancer. There will be 4 classes: class 0 made up of images of the 1st stage of colorectal cancer, class 1 made up of images of the 2nd stage, garbage class made up of images of the 3rd through 8th stages, and OOD class made up of images of the 9th stage. First, the neural network will be trained excluding the OOD class. Then the network will be calibrated to reduce overconfidence and run on the test set which includes OOD images. This will produce a percentage of how confident the network is that each test image belongs to class 0, class 1, and garbage class. The algorithm will collect every image that the network is unsure about (images with confidence levels less than 80% for all 3 classes). These images will make up the new class. Images in the new class should ideally be from the OOD class as the network wasn't trained on images from the OOD class. Finally, transfer learning will be applied to the network. During transfer learning the network will be trained on the new class as well as the class 0, class 1, and garbage class, resulting in a network that can identify images that belong to the new class. This network will be calibrated, and finally, the algorithm will be tested on all image classes. I expect the final network to achieve an accuracy of 90% for each class, producing an accurate network for high-risk applications with many OOD object appearances.

SCM103: Functional Causal Models for Gene Regulatory Networks in Single Cells

Single-cell RNA sequencing (sc-RNA-seq) is a powerful tool for studying gene regulation in cells. However, the complexity of the data generated by sc-RNA-seq can make it challenging to infer cause-and-effect relationships between genes. This issue can be solved by utilizing linear functional causal models to infer cause-and-effect relationships based on the presumption that one cause directly affects one effect. In this study, I aimed to determine whether linear functional causal models could be used to infer gene regulatory interactions from observational single-cell data. I used Poisson distribution, specifically a negative binomial distribution to represent the gene counts in single cells. Synthetic data was used due to the current technical limitations for data collection that cannot extract gene counts due to the limited material in single cells. I modified independent component analysis (ICA) that extrapolates a matrix of independent components or genes from our synthetic data. An algorithm for causal discovery called Linear Non-Gaussian Acyclic Model (LiNGAM) was applied to determine the linear relationships between genes and develop a causal model. The results showed that the modified ICA was more accurate in recovering the true, unmixed matrix of genes. However, LiNGAM did not show any improvement in the casual model's recovery. I concluded that our function modification for ICA was successful, but a different modification may influence a better LiNGAM graph recovery. Nevertheless, functional casual models are promising for inferring gene regulatory interactions, and further optimization will result in models that can provide insights into gene interactions and drug development.

SCM104: Neuralyze: A Computer Vision Tool for Quantitative Analysis and Monitoring of Parkinsonian Disease Markers

Rural populations in the United States have 50% less access to a qualified neurologist impacting diagnosis and treatment of Parkinson's disease in such populations. In addition, diagnosis of Parkinson's is based on visual clinical observations which are subject to misdiagnosis. To address these challenges, I wanted to evaluate a Telehealth solution using analysis of videos (from smartphones etc.) of patient's hand tremors and gait. My project objectives were to develop a video analysis algorithm to measure hand tremor frequency, amplitude, and gait speed for Parkinson's patients, verify the accuracy by comparing to accelerometer / stopwatch measurements, and to develop an approach to assess severity of the disease. In order to do this, I recorded 35 videos of hand tremors from 3 family members (simulated) and 1 actual Parkinson's patient. In addition, I took 28 videos of gait involving 4 family members including 1 Parkinson's patient. I compared the measurements from the video analysis with accelerometer and stopwatch measures and found the accuracy to be satisfactory. To perform video analysis, I created a Python code utilizing OpenCV, MediaPipe, and OpenPose libraries. These libraries helped convert video frames into models of hand and human frame with key focus points. My Python program was able to track the motion of these focus points over time to do the analysis. Based on my study, I proposed a Parkinson's severity scale. I concluded that video analysis can provide accurate measures of hand tremors and gait speed and aid in Telehealth for Parkinson's patients.

SCM105: Applying Kinematic and Kinetic Analysis to Optimize Four-bar Linkage Synthesis

The four-bar linkage is the simplest closed-chain linkage mechanism, allowing for the transformation and transmission of motion. While simple, its utility is vast and varied, from oil rigs to biological jaws. However, the development of such linkages for practical applications can be difficult when attempting to optimize or manipulate the kinetic and kinematic properties of the system under dynamic conditions. Current methods of linkage synthesis primarily involve creation of the motion (kinematics) of the system without focus on the forces (kinetics) behind it. To provide the full picture and aid in the design process, this study provides a set of equations that define various kinetic and kinematic properties, such as mechanical advantage, throughout the motion cycle of a user-inputted four-bar linkage. Subsets of equations are already well defined but only for specific points in time during the linkage's motion. However, this paper presents a generalizable set of equations that govern said properties over the entire motion cycle. So far, these equations have proven useful in the visualization and understanding of the user-defined linkage from an analytical perspective of not only the kinematics of the system but also the kinetics, allowing for easier optimization of desired properties. They provide an intuitive explanation for a variety of properties at localized, specific points (ex. toggle positions) while allowing for a global understanding of the properties through the cycle. Overall, the generalized formulae are able to aid in shortening the number of iterations spent during the engineering design process to simplify and optimize four-bar linkage synthesis.

SCM106: A Machine Readable File Format for Resumes

With the rise of online job applications, companies use Applicant Tracking Systems (ATS) to parse through hundreds of resumes automatically%u2014but with limitations. Often, ATS cannot understand a resume's formatting, or the file format itself is not compatible. And currently, ATS services cannot understand the resume. For example, if they cannot detect/distinguish/contextualize all dates in a resume, they cannot calculate the total years of work experience. To circumvent this limitation, application portals obtain machine-readable data by requiring candidates to manually enter information that could be found on their resumes into form fields. This is vastly inefficient. Therefore, I built the vResume (.vcv), a machine-readable file format specifically for resumes. It stores information (personal information, job experience, education, etc.) modeling the vCard format (a machine-readable file format that stores contact information). Usage of this format would ensure companies receive standardized, carefully labeled information that algorithms could understand. Job applicants would have less workload%u2014after making a vResume, manual data entry would not be required. Additionally, I built a graphical user interface (GUI) to easily make, read, and edit a .vcv file using HTML, CSS, JavaScript, and the vcard4.js library. I also developed a limited ATS software specifically for .vcv files to demonstrate the benefits for companies: this ATS can compare/rank applicants using information from their machine-readable .vcv files that standard ATS's may not be able to detect from PDF resumes. The vResume, GUI, and ATS perform well and may initiate a more data-driven, automated, and streamlined hiring process.

SCM107: Predicting lung, heart, and thoracic cavity volumes from subject demographics using machine learning to improve lung transplant

Lung transplantation is the standard treatment for end-stage lung diseases. A crucial factor affecting its success is size matching between donor's lungs and recipient's thoracic space. Computed tomography (CT) scans can accurately determine recipient's lung size, but donor's lung size is often unknown due to the absence of medical images. This study aims to predict donor's right/left/total lung, thoracic cavity, and heart volume from only subject demographics to improve the accuracy of size matching. A cohort of 4,610 subjects with chest CT scans and basic demographics, including age, gender, height, weight, race, smoking status, and smoking history, was used. The right and left lungs, thoracic cavity, and heart depicted on chest CT scans were automatically segmented using developed U-Net models, and their volumes were computed. Eight machine learning models were developed to predict the volume measures from subject demographics and validated using the 10-fold cross-validation method. The developed models showed promising performance in predicting thoracic cavity volume, right and left lung volume, total lung volume, and heart volume with R^2 ranging from 0.430 to 0.628, mean average error (MAE) ranging from 0.075 to 0.736 liters, and mean average percentage error (MAPE) ranging from 10.9% to 15.2%. The results demonstrate the feasibility of using subject demographics to predict lung, heart, and thoracic cavity volumes. Although a large dataset was used in this study, further clinical validation is required to assess its effectiveness in facilitating size matching for lung transplantation in real-world practice.

SCM108: Using Machine Learning to Analyze the Correlation Between Cancer-Driving Alterations and Sensitivity to Certain Drugs

Large-scale, pre-clinical pharmacogenomic studies provide an opportunity to develop methods for predicting cancer cell responses to different anticancer drugs and translate such insight to clinical settings. Clinical trials can be expensive and time-consuming, whereas the inclusion of this data can help during the process. By using models that look at clinically relevant oncogenic alterations and correlation with drug sensitivity, gene-drug interactions are effectively encapsulated and help guide the future treatment of patients. In this project, machine learning is used to investigate driving genomic alterations of cancers as possible predictors of variations in drug sensitivity across 1,001 cancer cell lines screened with 265 anti-cancer compounds. Using genomic alteration data and drug response of cell lines as input, I first performed linear regression on the genomic features to predict the IC50 values for the gene-drug interactions. Then, I performed logistic regression using the genomic data and discretized drug-response values. The results showed that the performance of regression using IC50 values was unsatisfactory, whereas predicting discretized drug response using logistic regression had encouraging results.

SCM109: Identifying Macrophage Polarization Markers in Breast and Ovarian Cancer

Breast and ovarian cancer are in the top ten most common cancer types in women in the world. Moreover, both cancers largely show no symptoms in their early stages, and symptoms thereafter are not clear either. Understanding genomic data for breast and ovarian cancer can help diagnose cancer in early stages and implement targeted gene therapy. The purpose of this project is to identify novel differentially expressed genes in high versus low macrophage tumors (high macrophage tumors promote cancer growth) in ovarian and breast cancer patients through a bioinformatics analysis. Studies show augmented expression levels of CCL2 and IL6 genes in breast cancer, and high expression levels of TNF and CSF1 in ovarian cancer. I expect to see similar results along with additional novel genes. I utilized publicly available RNA sequence data and the programming language R through the software R Studio. First, I created pseudocode for my program deciding which datasets, computational techniques, and R packages to use. My code consists of three main parts: data pre-processing, differential expression analysis, and data visualization. Patients were sorted into either a high macrophage ratio (associated with pro-tumor) or low macrophage ratio. Differentially expressed genes were found based upon their gene expression data and their macrophage ratio. Correlation plots and Pearson's correlation constant were used to analyze results. This procedure was replicated for both breast and ovarian cancer patients. I completed a literature review which verified my methodology, compared and contrasted results in breast cancer versus ovarian cancer, and helped identify new target genes for treatment. Experimentation is still continuing, and results will be available on fair day.

SCM110: An Iterative Neural Network Based Approach to Automated IFT-20 Sensory Neuron Identification in Caenorhabditis elegans

Determining neuronal identity in imaging data is an essential task in neuroscience, facilitating the comparison of neural activity across organisms. Cross-organism comparison, in turn, enables a wide variety of research including whole-brain analysis of functional networks and linking the activity of specific neurons to behavior or environmental stimuli. The recent development of three-dimensional, pan-neuronal imaging with single-cell resolution within Caenorhabditis elegans has brought neuron identification, tracking, and activity monitoring all within reach. The nematode C. elegans is often used as a model organism to study neuronal activity due to factors such as its transparency and well-understood nervous system. The principal barrier to high-accuracy neuron identification is that in adult C. elegans, the position of neuronal cell bodies is not stereotyped. Existing approaches to address this issue use genetically encoded markers as an additional identifying feature. For example, the NeuroPAL strain uses multicolored fluorescent reporters. However, this approach has limited use due to the negative effects of excessive genetic modification. In this study, I propose an alternative neuronal identification technique using only single-color fluorescent images. I designed a novel neural network based classifier that automatically labels sensory neurons using an iterative, landmark-based neuron identification process inspired by the manual annotation procedures that humans employ. This design labels sensory neurons in C. elegans with 91.61% accuracy.

SCM111: Biomarker Data Analysis for Diseases

Please visit student's exhibit for abstract

SCM112: Production of a Cadet Challenge Fitness App

Please visit student's exhibit for abstract

SCM113: Using Artificial Intelligence to Identify and Mimic Sounds

Artificial intelligence is a rapidly growing field and has made many groundbreaking advances in the past decade. With image generation software, we are now able to create images from simply a prompt as shown by DALLE-2. With sequential deep learning, we are able to make coherent chatbots that seem very realistic, like CHAT GPT. I wanted to explore this same technology in audio and sound. AI generated music has been made, but it does not fully take advantage of AI's full potential. My project will be setting the foundation for AI created sounds. Synthesizing audio, along with the same for images, has countless applications. I have been working on a simple neural network that is able to identify sounds. Based on this same concept, I will be setting the foundation for it to mimic the sounds it has been trained with. The neural network is currently being trained and adjusted, but it is on track to be a successful project.

SCM114: Clickbait Classification and Spoiling Using Natural Language Processing

Clickbait is the practice of engineering titles to incentivize readers to click through to articles. Such titles with sensationalized language reveal as little information as possible. Occasionally, clickbait will be intentionally misleading, so natural language processing (NLP) can scan the article and answer the question posed by the clickbait title, or spoil it. We create two models, one to classify the clickbait (Task 1), and one to spoil the clickbait (Task 2). The data used contains 5,000 entries of titles, articles, spoilers, and metadata. The first model has inputs of the post's text and the post's content. There are three types of spoilers: phrase, paragraph, and multi. Phrase spoilers are shorter than 5 words. Paragraph spoilers are longer than 5 words. Multi-spoilers are non-consecutive blocks of text that all answer the question posed by the title. The second model has the inputs of the previous model and will also use the output from the previous model. Because the spoiler is contained in the article, we frame this task as a question-answering approach for identifying the starting and ending positions of the spoiler. Task 1 uses basic accuracy scores as an evaluation metric. Task 2 uses the BLEU-4 score. BLEU is a score between 0 and 1 that calculates the similarity between a reference text and a predicted text. It computes the geometric average of the precision values for n-grams for n = 1 to n = 4 inclusive common to both texts, multiplied by a penalty value for short predicted texts.

SCM115: Implementation of Convolutional Neural Networks in Computer Vision For Self Driving Cars

Please visit student's exhibit for abstract

SCM116: CRAB: A Camera Combatting School Shooters Through 3D Reconstruction and Computer Vision

Current cameras for use in schools utilize expensive sensors for the use of combatting active shooters. Through the utilization of 3D Monocular Reconstruction in tandem with computer vision, school districts will be able to save $4,950 per camera for the use of combating active shooters. With school districts buying at least 100 high-tech cameras for their schools, this will save districts at least $495,000 per system. This ensures that money is not an issue in prioritizing student safety: school districts that lack funding will still possess the ability to to protect themselves against the threat of an active shooter.

SCM117: Leveraging Dense Neural Networks for Improved Hamiltonian Monte Carlo Sampling

This project introduces a combination of neural networks and Hamiltonian Monte Carlo (HMC) sampling. HMC is a powerful method used for sampling from complex probability distributions. However, it requires hand-tuning of two parameters epsilon %u03F5 and number of steps L. The ability of a neural network to learn complex relations even when given high-dimensional inputs is leveraged to adjust the parameter epsilon %u03F5 during a warm-up period. The HMC algorithm after warm-up is not altered to preserve ergodicity, which guarantees convergence to the desired target distribution given that this distribution exists.

SCM118: Analysis of Golf Swing Plane using Computer Vision

Computer vision has various applications in the world, including in the context of athletics. This project investigates its applications in a specific component of a golf swing. The swing plane of a golf swing is an imaginary planar surface used to describe the path and angle in which a golf club travels throughout the swing. Its position at different points in the swing directly impacts the trajectory of the shot resulting from the swing and is therefore critical in an overall swing analysis. This project uses principles of computer vision to analyze a golfer's swing plane in a video throughout the backswing portion of the movement. It first establishes an ideal swing plane based on the golfer's shoulder, hip, and clubhead landmark positions at address (the beginning of the swing). The program will identify these landmark positions using machine learning models that have been trained to pinpoint these specific points on the body and club. Then, the program will do several calculations to determine the ideal swing plane for the golfer. It will perform a frame-by-frame analysis of the video. For each frame, it will compare the golfer's actual swing plane to the ideal swing plane generated by the program and output a number in degrees indicating how accurate the golfer's swing plane is. This angle measurement can assist golfers in improving their swings by analyzing an important metric that impacts the trajectory of the ball and therefore their overall performance in the sport.

SCM300: Improving Health Literacy with Machine Learning

Health literacy is a major yet overlooked problem in the US. It disproportionately affects those with low income, low education, and those over the age of 50. Health illiteracy harms these groups by lowering safety, increasing hospitalizations, and increasing costs. We will be utilizing a BiLSTM (Bidirectional Long Short-Term Memory) machine learning model using OpenNMT. We hypothesize that sentences can be translated to become more readable through a machine translation model, which would help to provide a solution to health illiteracy. We are conducting the project using the following key steps: conduct background research to better understand the topic, look online for health illiterate sentences, create a dataset using the sentences collected online, manually translate sentences in the dataset to create a target for the machine learning model, develop a model to translate using the manually translated sentence and the original dataset, generate a translation score that assesses the readability of the sentences, fine-tune the model to optimize the model, draw conclusions from the model about the effectiveness and usability of the model. We will use the BLEU (BiLingual Evaluation Understudy) score metric to evaluate the quality and health literacy of the sentences that our model generates. The BLEU score assesses a sentence based on its readability and provides a standard with which to measure our translations. The final data analysis and the conclusion will be available on the date of the science fair.

SCM301: Early Diagnosis of Parkinson's Disease Using Machine Learning

Parkinson's disease is a progressive disorder that affects the nervous system. There is no specific test to diagnose Parkinson's, making it difficult to diagnose until it has already progressed a significant amount. This project aims to diagnose Parkinson's disease more efficiently through Machine Learning, so that it can be caught in its early stages, allowing for better patient care. Our experiment is still in the process of being completed. We are using datasets consisting of medical information about patients who have been diagnosed with Parkinson's disease. We are then cleaning and filtering the data, and training a machine learning model to recognize patterns across patients with Parkinson's. After training, given a patient's medical information, the model will be able to predict whether they have Parkinson's disease or not.

SCM302: Artificial Intelligence in Medical Imaging

Please visit student's exhibit for abstract

Pittsburgh Regional SCIENCE & ENGINEERING Fair
Powered by CARNEGIE SCIENCE CENTER

84th Pittsburgh Regional Science & Engineering Fair

Senior Division

Engineering / Robotics (SER)

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March 29, 2023

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Engineering / Robotics (SER)

SER100: Analyzing the Use of a Mouth-Operated Controller to Move Kinova Jaco Robotic Arm

Tetraplegia, the lack of motor skills along the spinal cord is a condition that imposes a need for wheelchairs and severely limits the ability to complete common tasks such as opening doors and moving small objects. Since this condition stems from spinal-cord injuries, brain injuries, or cerebral palsy, it is difficult to treat, thereby warranting any solutions to improve the quality of life. Robotic arms can help subjects perform these tasks, but the traditional tool of joystick-controllers to maneuver the robot is not viable for tetraplegics. Therefore, alternative methods of operating robotic arms (such as Kinova Gen2 JACO) solely using the mouth, is proposed as an alternative. This mouth-operated controller would be placed in the user's mouth and require them to use their tongue on a few pressure points to enable precise movement of the robotic arm. To develop this method, a %u2018mouth-mouse' that offers controlled movement of the robotic arm in 3D, control of the rotation, and grabbing features must be engineered. Since the arm moves in all three axes, the 'mouth-mouse' will translate the user's input to manipulate the arm in a precise manner. The conclusions of this project could be useful to develop better assistive technology for tetraplegics, and all people with disabilities alike.

SER101: A Novel Method of Measuring Intraocular Pressure via Acoustic Engineering

The purpose of this research was to determine if acoustic engineering would be applicable to measuring intraocular pressure via non-contact tonometry. Our device consists of a series of small metal particles inside of a plastic tube. Four of the particles in the middle are magnetic, both to maintain a straight line, and to measure the response wave. Additionally, there is a magnetic particle on top, which is picked up and dropped by a magnet placed on top of the tube. The bottom particle is placed on the measured surface. Once the first particle is lifted and released the initial and response wave sent from the surface is measured through the degree of vibration in the magnetic particles. We will initially test on a control surface, steel and artificial bone, with both our device, and an oscilloscope to ensure that they are consistent. We will run 200 trials on both surfaces with both devices. Once we analyze the data, we hypothesize they will have consistent measurements, we will move onto testing on an artificial anterior chamber. We will run our device 200 times on the anterior chamber, increasing the pressure by 2 mmHg steps from 20 to 40, recording the true pressure, and response waves. Next, we will repeat the same process using a goat cornea trimmed down and placed in the same capsule as the artificial anterior chamber in order to control the pressure. We will analyze our data in Matlab in order to conclude if our response waves correspond to the true pressure. We anticipate that the device will be able to consistently, and accurately measure intraocular pressure. If successful our technology will be able to be incorporated into a new tonometer to accurately measure intraocular pressure in patients, and would be a small, portable, handheld, non-invasive form of tonometry.

SER102: Using Machine Learning to Assist Colorblind Drivers

Colorblindness has a significant prevalence in the United States today. Approximately 8% of the US population is colorblind. Colorblindness can affect driving, because people with red-green colorblindness see red or green as shades of brown. To solve this issue and help colorblind drivers, an easy-to-use and portable, pluggable device was created. The device uses machine learning to identify traffic lights and its current color and finally announces them to the driver. The machine learning model was initially trained using 5000 images of existing traffic lights found online. However, later on, due to accuracy issues the 5000 images were not used, and the model was re-trained after each trip using all the images it took during the current and past trips. The device was created by mounting the camera in the car and connecting it to a Raspberry Pi, a small portable computer. To test the machine learning model, 16 test trips were taken and the accuracy of each trip was calculated. The accuracies for the trips ranged from 23.08% to 100%. For the most part, the device can accurately tell the driver what color the traffic lights are. This device could help people, but needs more testing for real world scenarios, as the machine learning model needs to be fine-tuned further.

SER103: A Novel Computer Vision Based Device for On-site Detection of Microplastics in Water

The purpose of this project was to create a better system for detecting microplastic particles in water. Microplastics are particles of plastic smaller than 5 mm in width. Research shows that microplastics now are prevalent in water from oceans to potable water in cities. The current methods for detecting microplastics are unfortunately inadequate. I created a system that uses machine learning-based computer vision to detect microplastics in water samples. This system can be deployed on-site, making testing much cheaper, faster, and easier than previously possible. To create this system, I designed and 3D-printed a housing designed for easy transport and testing of samples. I used a microscope USB camera and a Raspberry Pi computer inside the hardware to review the samples. I then trained a custom computer-vision model to detect microplastics in the water by creating samples of water artificially contaminated with microplastics. Finally, I tested the accuracy of the system. To run these tests, I again created samples of artificially tainted water that I ran through the system to determine how effectively it detects the microplastics in the water sample. I collected samples of water with and without microplastics to detect both accuracy at detecting microplastics and to determine the false positive rate. Overall, the system is 97.3% accurate at detecting microplastics in water with an 8% false positive rate where microplastics are not present. The entire system was constructed for $166.75 and testing can be completed easily on-site and for approximately 30 cents per sample. This project has the potential to make detection of microplastics easier, cheaper, and much faster. The system could allow for more widespread testing of microplastics, facilitating research around such pollution and allowing more people to know if potentially harmful microplastics exist in their water.

SER104: Pneumatic Prosthesis for Kinesthetic Learning

A prosthetic-like physical therapy tool functioning using compressed air to help children with congenital limb deficiencies or amputations to learn kinesthetic abilities and fine motor skills before getting an official prosthetic. A setup using an Arduino to measure EMG recordings from the patient and another to take those signals and convert them to power a small motor which moves the syringe that compresses the air, therefore, moving the finger. The EMG recording will collect nerve impulses and send them into an Arduino system. One Arduino measures these recordings and then sends them to the next to have them translated to tell the motor to spin forward (clockwise) or backward (counterclockwise). Depending on the direction of the spin the syringe connected will compress or pull back air within a tube that extends into a 3-D printed finger. This air movement will either pull the finger back if the patient sent the signal to pull back or push out as if the patient were opening their hand. No current results are available, construction and testing are still in progress. Results will be available on the day of the presentation. Though quantitative data is not used with this project, all data will be qualitatively based on if the apparatus works and how well it works. Looking for continuous improvements and additions to the prosthetic. If functions and works well the goal of creating a prosthetic to help children learn to work with a false limb will have been accomplished, and work will be continued to improve upon the project, and hopefully introduce it to a physical therapy setting.

SER105: Bandage Enhance Project

Since the 1920s, Band-Aid® has been dedicated to creating an adhesive bandage with an absorbent center to keep wounds protected from bacteria or other germs while they heal. These quick-to-use wound treatments have the potential to be used on any physical wound; however, they are limited by their inability to be customized. At times, a wound is too small, too large, or even in a difficult place to cover, and the bandages are ineffective or do not stay adhered to properly protect the wound. This project will collect data on adhesive and tensile strength between medical tape used by generic bandages compared to polyurethane medical tape. The polyurethane variety is known to be more water resistant and breathable compared to standard bandages. To collect tensile strength, a force gauge and rotational motion sensor was used to record the force and distance both materials can withstand for a certain cross-sectional area. To compare the two adhesive forces, a prototype of a bending finger was designed and printed to record the data between the two materials. Additionally, two different machine learning models, CNN and KNN, both known for image classification, were used to help determine which shape should be created. Results from this study could open the possibility of customizing bandages on-site in hospitals, or other medical facilities to better fit the patient's needs.

SER106: Project O.P.E.G.S.

The quest for renewable energy grows increasingly more important as we begin to experience the effects of climate change. The oceans are a vast, largely untapped resource of renewable energy, especially because of their vast quantities of kinetic energy that go unharnessed. This project aims at developing a buoy system that uses electric induction to convert kinetic energy into electric potential energy. A buoy was set up with a rack and gear so that it converts linear motion into rotational motion, which could power a small A/C Generator.. The energy of the waves generated could be measured for each trial using their height and frequency. Then, a multimeter was hooked to the A/C Generator and was set up so that total voltage and amperage could be measured. Using Joule's law, power and energy can be found. Results, though not yet apparent, will be displayed at the fair. I predict that the generator will be able to pick up about 5% of the energy supplied to it by the waves. I would count that result as successful because if such a system was implemented on a large scale, a massive amount of clean energy could be reaped from the oceans.

SER107: An empirical evaluation of textiles for reusable menstrual pads

The purpose of this project is to evaluate the wicking, absorption, and waterproofing abilities of different types of textiles to find a combination well-suited for a reusable three-layer menstrual pad. I tested 16 fabrics, 4 selected from those that made each of the following claims: wicking, absorption, waterproofing, and two-in-one (claims to do both absorption and waterproofing). I conducted tests to measure wicking (outward wicking and downward wicking), absorption (maximum absorption and retention), and waterproofing of 4 10 cm square samples of each fabric. I completed 2 rounds of testing with the fabric squares before doing a third round with two types of three-layer fabric menstrual pads composed of the fabrics in each category that performed best in my tests and the cheapest fabrics in each category. I tested these pads against a disposable pad (Stayfree regular maxi pad). I found that fabric pads performed equally in waterproofing, similarly in absorption, but much worse in wicking compared to the disposable pad. However, as fabric menstrual pads can be reused time and time again, they are less expensive than disposable pads over time.

SER108: Which Type of Wheels Work Best on Mars

One of the most intriguing questions to this date is when humans would be able to colonize Mars. Our primary way of doing this is through autonomous robots, containing many interesting components, such as wheels that initiate as the building block of any robot. Interested in this, I took upon the challenge of trying to design the best wheel that would be suitable for the Martian Terrain. To solve this, I had to create and follow a design process that would help optimize my success. After spending hours of research on Martian wheels, I started to design each wheel using Computer Aided Design. I designed 3 unique wheels and used many external sources to aid me. After designing each wheel, I used a 3D printer to print each wheel. I tested each wheel in a traction test, first by pouring 2 liters of MMS-1 Mars Simulant into a 10%u2033 by 5.5%u2033 box. I then rotated each wheel one at a time, moving the wheel side to side and up and down for a total of 10 strokes each. I finally visually measured and recorded the traction of each wheel and identified the design flaws and benefits of each wheel. After designing and testing each wheel, my third prototype had optimal performance while testing. I concluded my experiment, realizing that the ability to filter the Martian Simulant is crucial, and having unique beams to aid in side-to-side traction along the tread of a wheel is very beneficial.

SER109: Battling Diabetes: Developing an Artificial Pancreas

Please visit student's exhibit for abstract

SER110: Structured: A Test of Designs

Within any kind of construction or engineering, there is a lot of emphasis placed on the type and amount of materials used. A popular material that hobbyists and modelers use is balsa wood due to its lightweight nature and relative strength to its weight. In this experiment,the focus was on using balsa to design a strong yet lightweight structure. In order to complete this, the balsa wood, along with super glue, was used to build a set of structures with varying numbers, ranging from three to eight, of vertical supports as well as different inward supports. To test strength, each structure was crushed with weights. The data from the testing shows a pattern with the structures having more vertical supports physically supporting more weight, but the structure that held the most weight for its own weight had four vertical supports. This structure held the second lowest amount, but was over three percent better than the structure that held the most weight (eight supports). Both of these top supporting structures had a basis of four sides, with the physical highest weight just doubling an extra vertical stick on each side. Unfortunately, not enough tests were conducted to prove that this was not a coincidence, so when more are completed, more of the data can be analyzed, using medians to avoid outliers, to find the best design out of the options. This means that the final results for this experiment will be able to be presented in full on competition day.

SER111: Hybrid Wind Powered Street Light

How can turbines be implemented in small geological regions? With global temperatures rising, global warming has become an issue due to the burning of fossil fuels as the main factor. This makes it important for renewable resources to be implemented as soon as possible. I realized a major flaw of wind turbines was that they required large areas of flat fields, so I came up with the idea for mini turbines to be built on top of street lights. With street lights everywhere on every road, it requires a source of energy that instead of the source coming from non-renewable sources, it can draw energy from the turbines. This allows for turbines to be placed on a global scale in areas like valleys, cities, small rural towns, mountain sides, etc, as well as reducing the amount of everyday electronic equipment that rely on non-renewable sources to power it. I did some research on wind speeds, (averaging around 9-10 mph in the average US city while around 20mph in coastal regions in the US), types of turbines and how much power they produce, how much power street lights require (around 70-78V), and found it possible for the turbines to produce enough energy to power the average street light.

SER112: Flywheel Energy Storage System (FESS)

Flywheels store electrical energy as rotational energy through a rotating mass. Advanced flywheel designs are made of carbon fiber materials and stored in vacuums to reduce drag and magnetically levitated to reduce friction. Permanent magnets can be used to magnetically support the rotating shaft. Permanent magnetic bearings are reliable, cost effective and have a long operating life. Kinetic energy in a flywheel can be calculated by $.5Iw^2$. Increasing the moment of inertia or angular velocity increases the kinetic energy stored. The moment of inertia can be calculated using $I=.5MR^2$ with M and R being the mass and radius of the wheel However there is a limit to the maximum tensile strength in the material of the flywheel. Depending on its purpose, the material may be cast iron, billet, steel, or billet aluminum. Data can be collected by measuring the angular velocity, voltage, and current produced. The use of permanent magnetic generators are reliable and efficient (75%-95%). The purpose is to design and increase the efficiency of the flywheel by varying the moment of inertia and angular velocity of the flywheel. The production and use of chemical batteries is environmentally damaging and requires maintenance. Flywheels have higher energy densities, more durable (low maintenance), and fast response and ramp rates.

SER113: Investigation of PEM Electrolyzer Efficiency

I will be designing and building a PEM electrolyzer. Then studying the effiency to the scale. So that I will be determine if PEM electroylosis is a viable way of producing eco friendly hydrogen for fuel cells.

SER114: Shake it Off: The Effect of Building Structure on Earthquake Resistance

Earthquakes kill thousands of people yearly, and a large chunk of those people die from building-related deaths. I wanted to see if I could reduce the number of people dying from building-related earthquake deaths. To do this, I first built three model buildings: one rectangular building, one rectangular building with a TMD, and one triangular-backbone building. I created a shake table and placed each of these to the test by shaking each of the buildings five times at three different speeds: low, medium, and high. I tested how long they would shake after continuous shaking for five seconds. Surprisingly, the data showed that the TMD building did best, rejecting my hypothesis that the triangular-backbone building would withstand the test best.

SER115: Demonstration of the Hydrogen Energy Cycle Using a PEM Fuel Cell.

An experiment was set up to demonstrate how hydrogen could be generated through electrolysis and used to produce electricity in a reverse Proton Exchange Membrane (PEM) fuel cell process. The first stage of the project demonstrated that the high-purity hydrogen could be generated through electrolysis using a Proton Exchange Membrane (PEM) assembly with controlled power input. In the second stage, a solar panel was activated and powered the electrolyzed PEM cell to generate hydrogen. Then, the hydrogen was fed into a Proton Exchange Membrane Assembly to generate the electricity needed to power a fan. Finial, the energy cycle efficiency was analysis base on experimental data. Future experiments demonstrating this concept could be done using solar power instead of a power source from an outlet. The advantage of using solar panels and renewable energy can make the system completely eco-friendly, as the only byproduct is water.

SER116: What is the minimum density needed to print a usable 3D limb?

What is the minimum density needed to print a usable 3D limb? Throughout the years 3-D printing has made producing objects less expensive. 3-D printing can make prosthetics less expensive if they can be made durable. My experiment is going to determine the density of an object and , testing if the object printed is usable. Testing to see how much force it can withstand by using the force meter. Experimentation is ongoing and results will be provided at the science fair

SER117: How the Structure of an Egg Can Support Immense Weight

Architecture is found all around us; whether it is a rural farm or New York City, we use architecture every day to solve real world problems. It is why we have a safe place to live and why skyscrapers can touch the clouds. Devising a new way to rethink architecture could be crucial to building a future that the next generation will inherit. My project exemplifies how something that is thought by many to be fragile, an egg, can be transformed into something capable of supporting objects over ten times its own weight. Due to the natural geometry of an egg, little adjustments need to be made to present the architectural capabilities of something previously thought to be delicate. By placing bottle caps on the vertices of four eggs, this allows weight to be evenly distributed throughout the entirety of the shape.

SER300: Reducing Illegal Tractor Trailer Parking On PA Turnpikes

Please visit student's exhibit for abstract

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84th Pittsburgh Regional Science & Engineering Fair

Senior Division

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Earth and Environment (SEE)

SEE100: Examining the Relationship Between Lyme Disease Cases and Mammal Populations in Pennsylvania

The purpose of this research project is to determine how temperature and precipitation have affected Lyme disease case counts in Pennsylvania. Lyme disease is a part of a complex ecosystem, and this research examines one possible factor for the increasing rates of Lyme. To find a relationship between Lyme case counts and temperature and Lyme case counts and precipitation, data sets have been collected from previous studies. Statistical analysis through the program R is used on the data to determine correlation. The relationships are made visual through graphs. It is predicted that as temperatures increase over time, Lyme cases will follow that trend. There are many possible explanations for this. Tick survival is more likely with higher temperatures. Additionally, animal behavior is affected by both precipitation and temperature. By drawing a correlation from the previous 10 years, the data can be extrapolated to predict how climate change will affect Lyme disease rates.

SEE101: What is the Fundamental Niche of Breeding Blue-Headed Vireos in the Eastern U.S.?

The purpose of this research is to better understand the habitat preferences of Blue-headed Vireos (BHVI) to aid in guiding forest management in the Central Appalachia region. To find this information, the first BHVIs arriving on the landscape need to be studied, since they are the ones who will choose the most favorable habitat due to low intraspecific competition. To pinpoint the first arriving individuals, AudioMoth recording devices will be dispersed during early spring in areas of interest, and the sounds they capture will be analyzed as spectrograms with an AI program to find BHVI song. My role in this research is to train the AI by preparing samples of BHVI song for it to learn. This will consist of taking pre-existing recordings from Xeno Canto, a digital library of bioacoustics, and editing them on Raven Lite, a spectrogram analysis software, to isolate BHVI vocalizations in each recording. I hope to successfully train the AI so that it is ready for use this spring when the AudioMoths are deployed. The goal of the National Fish and Wildlife Foundation's Central Appalachia Habitat Stewardship Program is to restore and sustain healthy forests, rivers and streams that provide habitat for diverse native bird and aquatic populations. By learning more about BHVIs in this region, future forest management projects can be tailored to meet their specific requirements.

SEE102: Reconstructing Paleoclimate Conditions of Lago Frio in Northern Patagonia

The purpose of this research was to determine the relative strength and location of the Southern Westerly Winds in Chile over the past 1,200 years. Lake sediment was gathered and divided into 1 cm depth increments. The samples were extracted into a vial using hexane, isopropyl alcohol, and dichloromethane solvents. The lipids extracted from the samples were then transferred to a mass spectrometer where they were analyzed to determine the temperature and precipitation conditions of the area surrounding the lake. The data collected from these samples will be compared to other lakes in Chile that lie at different latitudes to measure any changes in the Southern Westerly Winds. It is hypothesized that samples gathered from a deeper depth will show greater levels of precipitation and cooler conditions than the samples gathered closer to the surface. The results gathered from this research will help create a better understanding of the climatic effect that the Southern Westerly Winds have on South America and the entire planet. With this research, I will hope to be able to provide some answers for the change in climate in Chile over the past millennia including the current megadrought occurring in the majority of the country.

SEE103: Mighty Mangroves

On December 26, 2004, a magnitude 9.2 megathrust earthquake unleashed a powerful tsunami off the west coast of Sumatra, Indonesia and 14 other countries costing the loss of over 200,000 lives. The destruction the tsunami caused was devastating, people across the world united to help the survivors. Tsunamis are a powerful force of nature, they can change the features of a coastline and result in millions of dollars in economic loss. Can anything be done to reduce the damage caused by tsunamis? In this project, the model of a mangrove will be tested against a simulation of a tsunami to see if mangroves may be the solution to reducing the destruction caused by tsunamis.

SEE104: Light Effects

Many people want to grow plants in an efficient and inexpensive way, but do not know what the best light source is to use for the best results. My experiment provides information about what the best light source would be to grow plants in an efficient way. To determine what light source is the most effective, I am using different types of light including; red, blue, green, yellow, white, sunlight, and a grow light, to grow garden cress seeds for 27 days. I turn the lights on from 5 a.m. to 5 p.m., and water the plants every day. The results of this experiment will be available on Fair Day.

SEE105: The Effects of Pseudomonas putida on Lumbricus terrestris

A recent study in 2020, found that Pseudomonas putida produces enzymes which break down polyurethane plastics. This could decrease the amount of time it takes for some plastics to decompose in landfills. Lumbricus terrestris, more commonly known as earthworms, eat bacteria in the soil, meaning they would be consuming the Pseudomonas. My experiment tests the Pseudomonas putida's effects on Lumbricus terrestris (earthworms) to determine if the introduction of this bacteria will have negative effects on the environment. To do this, a blinded experiment was conducted. I had a test size of forty worms per group. Twenty tubes of nutrient broth were inoculated with Pseudomonas putida. I had one infected group and one control group, each with forty worms. After that, I recorded the initial heart rates and reaction times of each worm and I placed two earthworms into each of the forty containers. I collected data for the heart rates throughout my experiment, and I collected data for reaction times at the beginning and end. After nine days of testing, the treated group showed no statistically significant changes in heart rate and reaction time. The control group and treated group stayed similar throughout the experiment, rejecting my hypothesis that the Pseudomonas putida would cause slower heart rates and reaction times in the Lumbricus terrestris.

SEE106: The effects of microplastics on Daphnia magna

Microplastics are particles of plastic that are less than five millimeters in length that come mainly from synthetic clothing, tires, face cleansers, plastic bags, bottles, and fishing nets. The purpose of this experiment is to determine if microplastics affect Daphnia magna's heart rate. I anticipate that microplastics will affect the heart rate of Daphnia magna in an abnormal, negative manner. The reason this was predicted is because plastics have been found to decrease the heart rate of other aquatic species. To conduct this experiment, plastic water bottles were cut up into pieces, less than five milliliters in length. The control group consisted of Daphnia magna and spring water, and the variable group included Daphnia magna and microplastics. The heart rate was measured for each organism. Everyday, three pieces of microplastic were added to the treatment group. This procedure was repeated for seven days. It was determined that microplastics affect Daphnia magna negatively, in a significant manner, decreasing the heart rate of the organisms.

SEE107: Abandoned Mine Drainage Water Bioindicators

When AMD water contains high levels of minerals like lead, copper, or iron, organisms cannot survive in the water, and therefore are not able to naturally filter the water. The purpose of this project is to make sure that high levels of limestone in the water will not affect microorganisms that live in the water. Research has shown that Daphnia are helpful bioindicators of water pollution because their rate of reproduction changes when they are in different qualities of water. Last year, this project was started by filtering AMD water using a lime softening method and aeration. This year, the focus is to repeat the method , but also use reverse osmosis to reduce the limestone concentration in the water to observe if there is a difference in the Daphnia's rate of production. The data will compare the Daphnia's production in the water that is filtered using reverse osmosis with the untreated AMD water and the treated lime softened water. The Daphnia grown in the reverse osmosis filtered water is expected to reproduce more than when living in the AMD water and the lime softened water. Data collected will be the amount of Daphnia produced in each water sample. No conclusion has been drawn yet.

SEE108: Impact of Nitrate Levels through Various Feed Types on Fish Health

Nitrate is an inorganic compound that affects how blood carries oxygen; therefore, it can turn hemoglobin into methemoglobin. This prevents any oxygen molecules from binding together which decreases the availability of O2 to tissues. The most common cause of high nitrate levels is overfeeding. This project explores which kind of fish food when used to overfeed raises nitrate levels higher. While daily nitrate levels are recorded, observing the fish's physical changes will also be monitored in order to help future people recognize when nitrate levels are increasing. This will be done so by first dividing eight fish in half into two separate tanks and for 3 days they will be fed normally to adjust to their environment. The next 10 days will follow how a fish reacts to being overfed fish flakes, two different kinds, with an increase of 1 pinch of food per tank every two days. Physical changes and nitrate levels will be recorded throughout the process, with great attention on both values in order to maintain appropriate fish health. The experiment is ongoing and data/results will be determined by presentation day.

SEE109: The Effects of Light Pollution on Phaseolus vulgaris

The purpose of this project is to determine if light pollution will negatively affect the development of Phaseolus vulgaris. Light pollution is a major problem facing our society today causing a multitude of issues to humans and the environment. It was hypothesized that light pollution would negatively affect the development of Phaseolus vulgaris because their photoperiod will be extended causing overgrowth and underproduction of beans. Five groups containing twelve beans each were exposed to varying amounts of fluorescent lighting. Each group was given eight hours of grow light a day and then each group was given either six, eight, ten, or twelve hours of fluorescent lighting. Developmental stages of bush beans outlined by the North Dakota University School of Agriculture were utilized to track each individual bean's development. An ANOVA test was run showing a significant difference between the five groups. A Tukey test was run to determine when there was a significant difference between each group during every stage. There was a significant difference between each group by the third stage of development. The plants exposed to more light pollution had a significant difference in time of development. The tests show the data to be statistically significant and support the hypothesis that light pollution negatively affects and slows down Phaseolus vulgaris plants.

SEE110: How Bad is the Air Quality from a Company Fined Millions

Steel industries are constantly being fined millions upon millions of dollars for air pollution violations that are considered to be extremely hazardous or even fatal. This research aims to measure one of the central toxins, chromium VI or hexavalent chromium, found in steel mill locations. I will calculate my data while being exposed to steel mill air pollution with an air monitor that measures this chemical element in which I will then compare to other hazardous sources people are willingly being exposed to daily that also erect chromium VI. After I have collected my data from the different sources, I will then proceed by interviewing both a US Steel representative and an Allegheny County Health department representative to gain a better understanding of what exactly US Steel is doing to prevent further harm to our atmosphere along with what exactly the Allegheny County Health Department is doing to make the air we breathe healthier. This information will assist my conclusion and show the air quality coming from US Steel overall educating the public on their surroundings and a small step forward to solving this worldwide concern.

SEE111: Survival of the Fittest: A Look Into Plant Growth

Please visit student's exhibit for abstract

SEE112: Sequencing Hellbender DNA

Identifying habitats of endangered species is essential to protecting those environments. However, many survey methods disrupt the areas of potential habitats and rely completely on the researcher's ability to find the organism being searched for. eDNA presents an opportunity to learn about the organisms an ecosystem supports through a non-invasive method that relies on detecting DNA presence rather than catch and release. DNA can be isolated from a water sample and then amplified using a primer specific to the target organism. This amplified DNA can then be sequenced to further confirm that the DNA from the sample is an exact match for DNA from the target organism. In this study, the target organism was Cryptobranchus alleganiensis in a local stream, the Little Connoquenessing Creek. Previous research has confirmed the potential for the habitat. Early amplifications yielded low Cq values indicating a high presence of DNA. The DNA was amplified again to get it to a higher concentration. Concentration and purity were checked using electrophoresis, spectrometry, and fluorimetry at various stages throughout the amplification and concentration process. The concentrated, purified, and amplified DNA is being sequenced through Azenta, and results will be available on the day of PRSEF. If the sequenced DNA matches the sequence from the gene database, the presence of Cryptobranchus alleganiensis can be confirmed in the tested area.

SEE113: Finding the Limit of Detection of a qPCR using eDNA

Environmental DNA, also known as eDNA, originates from cellular material shed by organisms, and it is typically used to track species without disturbing the surrounding wildlife habitat. Because eDNA is shed into the environment, the amount of eDNA in each sample is low after being purified; therefore, eDNA may have been undetected based on the optimal range of Cq values for eDNA in a qPCR. This research was conducted to determine whether a limit of detection of a qPCR can be found through a sample collection of Cryptobranchus alleganiensi, also known as the hellbender salamander. If there is a correlation between the eDNA and its Cq values, then the limit of detection can be found using a DNA and negative sample in a qPCR, and this Cq value can be quantified as a concentration through the Qubit Fluorimeter. The water sample collected for this study was sourced from the Pittsburgh Zoo & PPG Aquarium. After collecting the sample, the eDNA was extracted and diluted to create smaller concentrations of DNA. While the sample ran through a qPCR to obtain Cq values, it concurrently ran through a PCR to amplify the DNA. This amplified DNA ran through a Qubit Fluorimeter to find the exact concentration of DNA in ng/μL. The experiment is still ongoing; therefore, results are not concluded yet. Through this research, finding both the Cq value of the limit of detection as well as its measurement in ng/μL can increase the precision of eDNA studies in Pennsylvania.

SEE114: The Effect of Glyphosate on Plant Growth

The purpose for completing this project is because people are using more and more harmful chemicals like glyphosate on plants without thinking about how it may negatively affect the next generation of plants that are planted in that soil. For my project I will be testing the fungal to bacterial ratio in soil that has been sprayed with the herbicide glyphosate and also observing how plants grow in the treated soil.

SEE115: Natural is the New Look: Color Quality of Natural Dyes

Please visit student's exhibit for abstract

SEE116: The Effect of Rock Salt on Roadside Plants and their Growth

Previous studies have reported several links between road salts and roadside plants' health. However, the task of disclosing the least toxic road salt for a plant's health and environment is yet to be investigated. This study is performed by creating two experiments, one to determine the highest level of toxicity that roadside plants can remain viable in, and the second to determine which chemical makeup of road salt is least detrimental to the plant's cells and growth. To attain these results, the first experiment allowed seeds to germinate in different concentrations of aqueous NaCl solutions. This experiment was performed to determine the level of highest toxicity. Using the results from this experiment, a supplementary experiment was subsequently performed. The second experiment was conducted by planting milkweed seeds (a common roadside plant) into pots and watered with various aqueous rock salt solutions. This experiment determined which rock salt is least detrimental to plant growth. The results formed from the experiment, any salt concentration past 0.25 impedes germination. Comparing the results of the pure water-soaked seed and the 0.25M NaCl-soaked seed, a clear difference can be seen in radical length. The pure water-soaked seed had an average radical length of 1.78 cm, while the 0.25M NaCl-soaked seed had an average of 0.84 cm. While executing the supplementary experiment, a critical question surfaced. The period of how long the salt stays in the soil is yet to be discovered and warrants further research. Extrapolating these results, communities can use them in several ways to assess which rock salt is best for their specific community, factoring in cost, toxicity, and duration of time the salt is used throughout the year.

SEE117: Zinc Run-off Effects on Algae Population Growth

The purpose of this experiment was to determine if different concentrations of zinc effect the growth of populations of algae. There are four different experimental groups and one control group, and the experimental groups all were exposed to different concentrations of zinc while the control had no zinc added to it. Quantitative measurements were the amounts of algae grown measured using a spectrophotometer and were collected every 24 hours for 10 days. The data collected will be graphed and looked at over the courses of 10 days and a line of best fit will be used to analyze the effect zinc had on the growth of algal populations. The zinc will be thought to reduce the growth of algae at higher concentrations and at lower concentrations/no zinc the algae will grow best. There are many applications to society including testing this effect zinc has on algae because many factories have runoff and waste containing heavy metals including zinc as well as fertilizers used to help plants grow contain zinc. Also, many different salts used in the winter to remove snow off the roads and sidewalks contain zinc. All this runoff eventually leads to rivers and ponds where algae grow and can lead to eutrophication.

SEE118: The Effects of Household Items on Air Quality

Volatile organic compounds (VOCs) are emitted into the atmosphere as gas and include a variety of chemicals, which potentially have adverse health effects. Organic chemicals are widely used as ingredients in household products, however, the average homeowner does not think about the variety of sources within the home. Using a variety of common household products (such as latex paints and stains, foams, fabrics, and plastics) and an air quality monitor, I will evaluate the possible effect that these products have on air quality within the home. This experiment is ongoing and results will be available on fair day.

SEE119: Effects on Plant Health with the Use of Precipitated Silica and Clay Rich Soil

The Greater Pittsburgh region is primarily composed of clay-rich soil from the weathering of shale and its minerals into the ground. Clay soil is an immensely difficult substance in agriculture, as it usually converts into hard, dense rock-like chunks during the colder months, restricting root growth and the movement of water and air. Its texture can also be a challenge when planting in the wet months as it can congeal into a thick substance with little air being let in. Soil amendments, such as sand, gypsum, and compost, have all been used as a way to address the issues of clay soil, but they still contain many disadvantages. Precipitated silica, a form of SiO2, has never been used as a clay soil amendment before. In theory, its amorphous and jagged structure would allow aeration and increased porosity to the soil, eliminating some of the faults of clay soil. To see the effect of precipitated silica on clay-rich soil, fifteen pots of marigolds were planted with 5 different rations of silica to soil (by mass): 0g, 1g, 3g, 10g, and 20g. The focus on this project will be the soil and plant health. The biomass, particularly the root mass, will be measured at the end of the marigold's growth, as well as pH and the differences in texture and water retention. Results are still being obtained but will be available the day of presentation.

SEE120: Ecological Comparison of Two Lick and Crooked Creek

Two local creeks %u2014 Crooked and Two Lick %u2014 were investigated to see which one may be less ecologically healthy. This may help determine which one requires more attention from conservationists, thus helping in the preservation of our natural resources in Indiana County. A macroinvertebrate sampling was done at each sampling site, as well as a collection of chemical data and QHEI data from both sites. While QHEI seemed to favor Two Lick, Crooked Creek was superior in both the sampling data and chemical data, with a very low pH. Thus, despite being a better physical habitat, Two Lick is suffering from a chemical pollutant, while Crooked is less heavily affected. The identity of this pollutant seems to be Acid Mine Drainage, from the abandoned Lucerne Coal Mines.

SEE121: Preen Part VII: Trifluralin Migration through the Soil Matrix

Preen is a pre-emergent herbicide that is popular among gardeners. According to the manufacturer, Preen will prevent weeds from sprouting but it will not harm seedlings that are at least 2 inches tall. The active ingredient in Preen is trifluralin. According to the EPA, trifluralin is very highly toxic to aquatic life with LC50 concentrations as low as 0.041 ppm for Rainbow Trout. Although toxic to aquatic life, trifluralin is not believed to be a significant hazard to groundwater and nearby surface waters because the chemical is thought to adhere to the soil particles. In a prior experiment it was noted that after 63 days the effectiveness of Preen in preventing weed germination was significantly reduced. In fact, after 63 days, the rate of weed germination in the Preen garden was almost identical to the rate of weed germination in the control garden. Potential causes for the decline of weed control effectiveness in the Preen garden include 1) degradation of the chemical effectiveness of Preen and/or 2) the Preen had been washed deeper into the soil matrix. The purpose of this experiment is to determine if the Preen is being washed into the soil matrix and potentially impacting shallow groundwater. Using a raised bed garden with a specially constructed underdrain system, groundwater samples were collected from a garden containing Preen and a control garden. These samples were collected following four significant rainfall events during the growing season. The collected samples were subsequently taken to a laboratory where the target chemical (trifluralin) was extracted from the water samples via the QuEChERS (Quick, Easy, Cheap, Effective, Rugged and Safe) process. Water samples with known trifluralin concentrations were also prepared in the lab and extracted to determine the recovery efficiency of the QuEChERS process. Following the extraction process, the extracts were analyzed via a liquid chromatograph-mass spectrometer.

SEE122: Harnessing the Power of Wind Turbines

Please visit student's exhibit for abstract

SEE123: Water Temperature in Relation to Added Carbon Dioxide

Water Temperature in Relation to Added Carbon Dioxide The world is increasing in temperature on average 0.14 degrees every year. My project proves that with larger amounts of carbon emissions, the earth's temperature rises. I wanted to find a way to prove that a lot of carbon dioxide heats air when trapped. To do this, I put one Alka-Seltzer Fizzy Tablet in a sealed container with a heat lamp on it, and then did this again with two tablets, and recorded the temperature every minute for fifteen minutes. After three trials, my hypothesis was proved since the two tablet containers had higher temperatures after fifteen minutes compared to the container with one.

SEE124: The Effect of Pollution in Western Pennsylvania on Plant Germination

How does polluted water affect plant growth? Plants need water in order to grow but human activities such as salting roads has led to water being polluted. I want to figure out how polluted water effect plants. To conduct this experiment I will expose seeds to different types of salt and record germination.Experimentation is ongoing and results will be provided at the science fair

SEE125: Improving Soil Quality Organically

Testing how much worms and pill bugs impacts soil. I chose this topic because I thought worms would be fun to experiment with because I used to find worms when I was little. I thought it would be good to know what certain organisms do to soil. I want to know how much worms and pill bugs can impact soil. I'm going to test every Tuesday and Friday for ph/nitrogen/phosphorus/potassium and at the end of everything I will test to see what soil is healthier - the one with pill bugs or with worms. Experimentation is ongoing and results will be provided at the science fair.

SEE126: Soil Quality as An indicator for Environmental Racism

Soil Quality as An indicator for Environmental Racism Environmental racism is often overlooked. Many low income communities as a whole have faced increased risk of mental illness, access to proper nutrition and healthy foods, clean air and water. I want to figure out which communities in my city are likely impacted by lower soil quality. I'm going to look at the different types of nutrients in the soil and see if the important ones are in there so plants can grow and thrive. Experimentation is ongoing and results will be provided at the Science fair.

SEE127: Survivability of local soil composition on Earth Worms

I am testing to see if earthworms can adapt to other soil then their normal soil which is loamy soil. Seeing if they can go under and survive like they do when there with their usual soil. Experimentation is ongoing and results will be available at the science fair.

SEE128: Climate Change Impact on aquatic organisms

Climate change causes the acidity of water to rise because it releases carbon dioxide into the water and increased temperatures make the carbon dioxide easily dissolved. My experiment will be changing the pH of different salt water tanks with brine shrimp and then examining the behavior and movement of the shrimp. Climate change is having a negative impact on ocean health and it is important to understand the impact on aquatic organisms. Experimentation is ongoing and results will be provided at the science fair

SEE300: Water's Effect on Plant Growth Continued

The purpose of this experiment is to test how different types of water impact plant growth. We are testing greywater, rainwater, well water, and deionized water against our control of tap water. We are testing on four different types of herbs: cat grass, parsley, thyme and cilantro. We will plant 20 samples of each herb, and four of each herb sample will be used for each water type. Each sample will be watered at the frequency specified by the instructions found on the seed packet. We will record the height of each sample every other day for four weeks. We will compare this data to come to our conclusion. We will also test the water types for hardness, iron, copper, lead, nitrate, nitrite, fluoride, cyanuric acid, alkalinity, carbonate, and pH. The information found by this experiment can be used to help conserve water by better understanding how water impacts plant growth and determining the best sources for water. Our results will be available on the day of the competition.

Pittsburgh Regional SCIENCE & ENGINEERING Fair
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84th Pittsburgh Regional Science & Engineering Fair

Senior Division

Medicine / Health / Microbiology (SMH)

Student Project Abstracts

March 29, 2023

Notes to Judges

Students prepare Abstracts limited to 100 words that include the following:

- Purpose of the experiment
- Procedures used
- Data
- Conclusions
- Possible research applications
- Minimal reference to previous work
- For continuation projects, the abstract should focus on work done since the last PRSEF
- Should not include: a) acknowledgments, or b) work or procedures done by the mentor

Many students continue their research after the Abstract is submitted, and therefore the Abstract may not fully represent the Project.

Abstracts are available to the Judges prior to the Science Fair as an aid in pre-screening the Projects. Judging is to be based on the actual Project as presented by the student.

Project Numbers are assigned as XYYABC

- X: S – Senior Division (9th through 12th grade)
- YY: Category Name
  - BS – Behavioral and Social Science
  - BI – Biology
  - CH – Chemistry
  - CM – Computer Science and Math
  - EE – Earth and Environment
  - ER – Engineering/Robotics
  - MH – Medicine/Health/Microbiology
  - PA – Physics and Astronomy
- ABC: Project number
  - 1xx or 2xx – Individual student projects
  - 3xx – Team projects (2 or 3 students)

Medicine / Health / Microbiology (SMH)

SMH100: Measuring Exposure to Atmospheric Chemicals Using Passive Samplers: Problems with PFAS

Per and Polyfluoroalkyl substances (PFAS) are a class of man-made chemicals, and several PFAS have been linked to health issues yet are still widely used in consumer products. I hope to investigate high school students' personal exposure levels in order to help inform them of healthier life choices to reduce PFAS contact. I will use silicone wristbands as passive samplers to track exposure levels of participants. I will also use a survey to track frequent locations and assess factors that may contribute to higher detection levels. The resources I will need are GC/MS and LC/MS-MS machines along with the chemicals necessary for extraction and testing. The data that I will collect is the concentration of the chemicals in a ~1 g piece of the wristband per test. I anticipate that students will have varied exposure levels to PFAS that can be attributed to different sources at locations where they spend their time when wearing the wristbands. With the results of my experiment, I hope to be able to advise students on how to help reduce PFAS exposure. Also, this data can help contribute to knowledge about airborne and dermal exposures to PFAS, which is under-researched compared to ingestion exposure.

SMH101: Controlling Vancomycin Resistant Staphylococcus aureus with Electroactive Bacterial Cellulose-Carbon Nanotube Composites

Bacterial resistance to antibiotics outpaces drug discovery, as researchers have not discovered a new class of antibiotics since 1984. One of these bacteria, Staphylococcus aureus, infects over one million people in the U.S. every year. S. aureus can form biofilms that harbor metabolically dormant persister cells that do not respond to current treatments. This study applied electrochemical therapy through bacterial cellulose-carbon nanotube composites to eradicate vancomycin-resistant S. aureus. Komagataeibacter sucrofermentans was cultured to produce a bacterial cellulose (BC) membrane at the air-media interface. Then, carboxyl-functionalized multi-walled carbon nanotubes (CNTs) were loaded into purified BC with surfactants, low-frequency sonication, and rotational incubation to create BC-CNT composites with high electrical conductivity. Chronoamperometry was used to standardize voltage potentials of the BC-CNT electrode, allowing low-level currents to flow between two terminal electrodes. Quantified fluorescent imaging of GFP-expressing cells demonstrated that electrified BC-CNT can inhibit S. aureus from forming biofilms. Bactericidal efficacy significantly improved when a 3.125 %u03BCg/mL vancomycin solution was added to the treatment (MIC of 12.5 %u03BCg/mL). Phenol red indicates oxidation and electrochemically driven water hydrolysis at the working electrode, which could be a killing mechanism. These results suggest a new treatment for overcoming drug-resistant S. aureus infection.

SMH102: Video Based AI for Heart Failure Detection

Currently, heart failure diagnosis using echocardiograms encounter inaccuracies because of inter-observer variability and the lack of consideration of systolic heart failure. In order to alleviate this problem, this project proposes an AI model that detects heart failure using echocardiogram videos. The project will be split into two models: one that detects diastolic heart failure and one that detects systolic heart failure. The diastolic model will be trained on data from the EchoNet Dynamic dataset and will use 4-chamber apical view echocardiogram videos to predict diastolic heart failure using ejection fraction, which is the percentage of blood that leaves the blood that leaves the heart after each contraction. The systolic model will be trained on data from the EchoNet LVH dataset and will use parasternal long-axis view echocardiogram videos to predict left ventricular hypertrophy, which is characterized by a thicker intraventricular wall. Python will be used to code the models and PyTorch, a library within Python, will be used to implement and manipulate the models. The two models will be judged based on their accuracy in predicting ejection fraction and intraventricular wall thickness respectively. The expected result are two models that, in conjunction, will have better results than precedented models that utilize echocardiogram images. One obstacle to this project is that the data from the two datasets are not linked, so testing the performance of the overall model will be difficult. This project can be used to aid heart failure screening by diagnosing diastolic heart failure and flag potential systolic heart failure patients.

SMH103: Intra-Amniotic Injections in Congenital Diaphragmatic Hernia

The purpose of this research was that there are no prenatal therapies consistently address both pulmonary hypoplasia and pulmonary hypertension and to see if intra-amniotic injections of sildenafil and rosiglitazone can achieve this goal. Three experimental groups and one control were set up. One control was no nitrofen gavage and a PBS injection. The other control was a nitrofen gavage and a PBS injection. The three experimental groups all had nitrofen gavages and were injected with Sildenafil, Rosiglitazone, and Sildenafil + Rosiglitazone respectively. The quantitative measurements were that the pups were weighed, and the lungs harvested and weighed for calculation of lung-to-body weight ratio (LBWR). In addition, small pulmonary arteries were measured for inner and outer diameters for calculation of the percent medial wall thickness (%MWT). I hypothesized that intra-amniotic injections of sildenafil and rosiglitazone would promote lung growth and reduce the pulmonary hypertension in the lungs. I expect that the five groups (healthy control, CDH control, CDH + sildenafil, CDH + rosiglitazone, and CDH + sildenafil + rosiglitazone) should differ significantly in LBWR as well as %MWT. CDH + sildenafil and CDH + rosiglitazone should result in slight lung growth compared to CDH control lungs. In addition, CDH + sildenafil + rosiglitazone should result in major lung growth compared to CDH control lungs.

SMH104: Effects of Food Additives on Probiotic Bacteria

Decreased levels of probiotic bacteria, such as the Lactobacillus genus, have been linked with increased incidence of depression. Processed food is generally avoided for its negative physiological effects and increases susceptibility to mental health disorders such as depression. This project evaluates whether common additives in processed foods contribute to development of depressive disorders by reducing probiotic bacteria counts through testing the inhibition ability of these food additives on a species of Lactobacillus found in the digestive system, Lactobacillus casei. Food additives were selected based on frequency of appearance in food products and added to agar plates or broth solutions in concentrations of 2 g/L, 5 g/L, 10 g/L, 20 g/L, and 30 g/L to determine if Lactobacillus casei growth was inhibited by food additives within processed foods. Research is still ongoing and results will be available on the day of the fair.

SMH105: Blood Sugar, Spice and Everything Nice

Not too many individuals enjoy injections, such as shots. What if there was a way that we could take all medications via swallowing them? This experimental model and experiment will investigate the challenge of making medication we can swallow quickly. Insulin will be the example used in the experiment. Insulin is a medication that is taken frequently by individuals with diabetes. The experiment will produce information on how functional medicine is after spending time in an environment equivalent to our stomach.

SMH106: Which Toothpaste Best Prevents Coffee Stains

Many people, including myself, drink coffee almost daily. However, the common issue is staining our teeth. I was an intern at the Shadyside Dentistry and they had a separate day for teeth whitenings. Many patients said they drank coffee. I was curious whether this was coincidental, or if coffee actually stains teeth. My experiment provides a look at which toothpaste is the most ideal for preventing teeth browning after drinking coffee. First, I used 6 teeth for each group and put each tooth into a container and labeled the toothpastes. The 4 toothpastes I used were Crest 3D, Colgate Optic White, Colgate Anticavity, and the Sensodyne Toothpaste. Second, I wrote each tooth's color using a Dental Shade Guide. Next, I poured the coffee into the teeth for 15 minutes. Then, I brushed the teeth for 2 minutes each. I put it into containers filled with water to represent saliva. I repeated this everyday. Every 3 days, I tested the colors of each tooth to compare from the beginning. After 2 months passed, I saw the Colgate Optic White toothpaste was the most efficient. I made a data table, with each tooth's shade numbers. I found the Crest 3D average net change was -1, the Colgate Optic White was -4, the Colgate Anticavity was -0.67, the Sensodyne Toothpaste was -1, and no toothpaste was 9.67. My experiment supported my hypothesis, that out of the 5 groups, the best toothpaste to prevent teeth staining was the Colgate Optic White Toothpaste.

SMH107: Isolation and Characterization of Porcine Optic Nerve Head Astrocytes and Lamina Cribrosa Cells

Background: Primary open-angle glaucoma (POAG) is a disease that causes gradual vision loss. The optic nerve head (ONH) contains retinal ganglion cells (RGC) which allow for sight. ONH contains the lamina cribrosa (LC), the primary site of injury in POAG causes the death of RGC. The LC yields two major cell types, ONH astrocytes and LC cells which synthesize extracellular matrix proteins to support and maintain the LC. As such, ONH astrocytes, and LC cells are needed to understand the mechanisms of POAG. To isolate and characterize these cells the hypothesis of Porcine ONH astrocytes are glial fibrillary acidic protein (GFAP) positive and Lamina Cribrosa cells are positive and alpha-smooth muscle actin (SMA) positive was tested. Methods: The LC was isolated from porcine eyes post-mortem by cutting the globe at the equator and trimming the sclera to leave the ONH. The lamina was isolated from the ONH using a 1mm biopsy punch. The LC explant was cultured in media. Cells of interest were preliminarily identified based on their morphology. The cells were stained with GFAP and SMA. Six well plates were fully stained with each antibody and mounted with 4%u2032,6-diamidino-2-phenylindole (DAPI), and six were left as a control group. Coverslips were imaged with an eclipse 90I microscope. Results: Porcine ONH astrocytes are star-shaped and GFAP positive while LC cells are elongated in shape and SMA positive. Conclusion: The study allows for a straightforward technique to isolate both ONH astrocytes and LC cell types from a single dissected porcine ONH.

SMH108: Influence of particle matter on athletic performance

The purpose of this project is to determine if there is a correlation between particulate matter and runner performance. Human participants (10 male and 10 female) will be asked to run two miles outdoors at an up-tempo pace (80-90% effort). Their VO2 Max will be calculated based on their time as a measurement of runner performance. Participants will repeat their timed two-mile once a week over the course of 5 weeks (5 trials). One control group will be set up to assess a runner's VO2 Max indoors. The air quality on each day that participants complete their two mile will be used in this study as a measurement of particulate matter. Data analysis will compare the VO2 Max of each runner to air quality. Some limitations may occur due to the fact that participants are a wide range of ages and therefore have different levels of athletic performance to begin with. The findings of this experiment could prove that high particulate matter negatively affects runner performance and influence Pittsburgh to improve their air quality.

SMH109: The Role of T Channel Inhibition via Rho Kinase in Nogo-Receptor 1's Restriction of Synapse Assembly During Development

Studies of synapse assembly help us understand how neural circuits contribute to learning and diseases of cognition. We previously showed that exposing brain slice cultures to nogo-66 protein, a ligand for Nogo-Receptor 1 (NgR1), reduces dendritic spines, major sites of excitatory synapses in the brain. While NgR1 signals intracellularly via Rho Kinase (ROCK) to alter cytoskeletal assembly, how it might block activity-dependent synapse development was unclear. We determined expression of a voltage-gated calcium channel (CaV3.1M1,M2 T-channel) mutant that cannot be phosphorylated by ROCK results in an increase in spine numbers, suggesting ROCK inhibition of T-channels may be a key component in NgR1 inhibition of calcium signaling in synapse assembly. To address this hypothesis, we exposed brain slices to Nogo-66 peptide for 48 hours, testing if Nogo's inhibition of spine assembly reverses in neurons expressing CaV3.1M1,M2+GFP. Neurons expressing GFP alone served as controls. Hippocampal brain slice cultures were fixed, GFP-labeled dendritic spines were imaged using confocal microscopy and volumetric analysis (Imaris) was used to classify spines using established parameters. Comparisons of mean spine density with a one-way ANOVA via Tukey's posthoc test (p

SMH110: Development of Annotated Brain MRI Dataset to Develop Machine Learning Algorithms for Neuroimaging Quality Control

Title: Development of annotated brain MRI dataset to develop machine learning algorithms for neuroimaging quality control Scholar: Arya Mehta High School/College/City/State: North Allegheny Intermediate High School, Pittsburgh, PA PI of group/lab: Dr. Pradeep Reddy Raamana/Open Minds Lab Mentor(s): Dr. Pradeep Reddy Raamana Site: CoSBBI Abstract: MRI scans are a non-invasive tool to detect brain abnormalities, but their utility is affected by unwanted artefacts. Accurately identifying artefacts is complex, especially for machine learning (ML) algorithms. In this project, I learnt to recognize different MRI artefacts and carefully generated an annotated brain MRI dataset to train ML algorithms. Introduction: MRI artefacts transpire from different discrepancies. Experimental errors contain objects that are beyond the confines of an image. During the scan, patient movement inside the machine causes subject motion errors. The interference of [foreign] radio waves result in noise and other hardware issues. Reconstruction errors result from parcellation mistakes during physical analyses. Patterns categorizing the specificity of the artefact through manual ratings can be detected computationally following the development of ML algorithms. Methods: Manual rating using the program VisualQC grants raters three dimensional cross sections of axial, sagittal, and coronal views of neuroanatomy. Raters adjust the illumination of each individual scan to better review regions of interest. Comparing slices within orientations of alike or differing views highlights the appearance of artefacts, should one be present. Results: We reviewed a dataset of 216 MRIs from the Amsterdam Open MRI Collection, and found that 90 images were blurry, 29 with ghosting, 2 had motion errors, 169 had a discrepant orientation or field of view, and 42 had ringing artefacts. Only 8 scans appeared to be free of any noticeable artefacts. Discussion: Accurate rating of these complex artefacts requires further training and practice, but our project has already contributed to improving VisualQC and the guidelines for rating by high-school students like me. On estimate, the first 100 scans were used to become familiarized with the patterns of each artefact for categorization. The completion of this set evaluated the tell-tale signs of each artefact for future analyses, and eventually, an automatic algorithm to detect artefacts.

SMH111: Using Bioinformatics to Investigate Cell Communication within the Tumor Microenvironment of Pediatric Glioblastoma and Diffuse Midline Glioma

Glioblastoma (GBM) and H3K27-M Diffuse Midline Glioma (DMG) are highly malignant brain tumors with low survival rates. The cellular compartment of the tumor microenvironment (TME) is composed of tumor and non-tumor cells (ex. immune cells). The dominant immune cell population in the TME of GBM and DMG comprises macrophages and microglia both of which are known to fight against pathogens, remove cell debris and initiate inflammatory responses. Communication between tumor cells and immune cells in the TME through paracrine signaling can promote tumor growth and targeting these could improve patient outcomes. To identify these paracrine signaling pathways, I used GBM and DMG single-cell RNA-sequence (scRNA-seq) datasets containing pediatric tumor samples. ScRNA-seq, a powerful technology, allows identification of the transcriptional profile of each individual cell within a tumor. After uploading selected datasets into R (a programming language and software), I used the CellChat package (an open-source R software package) to analyze cell-cell communication pathways between macrophages and tumor cells. Various networks outgoing and incoming from macrophage/microglial and malignant cells were identified such as Complement, Galectin, and CCL. There were also certain ligand-receptor pairings found from macrophage/microglia to malignant cells, the notable one being LGALS9 %u2192 HAVCR2. I identified the known signaling networks and pathways with the highest computed communication strength and p-values and then conducted a literature review to identify drugs targeting these pathways. For example, using monoclonal antibodies against HAVCR2 in the LGALS9 %u2192 HAVCR2 ligand-receptor pair could disrupt the paracrine signaling and potentially affect tumor growth.

SMH112: Cinnamomum verum and the inhibition of Rhizopus stolonifer

Mold growth on organic foods is a leading cause of food waste. Cinnamomum verum (cinnamon) has been shown to be an effective treatment against mold for soil germination and home mold infestations. My project focuses on different ways cinnamon can be used to impede mold progression on white bread, a common household food item. The mold used in this experiment is the most common black mold on bread, Rhizopus stolonifer. The bread was homemade to control the ingredients and to minimize any preservatives. Three different delivery methods were tested in this experiment to evaluate mold prevention: cinnamon directly placed in the environment of the bread, cinnamon oil coated wax paper wrapped around the bread, and cinnamon placed between two coffee filters and placed on the bread. The results statistically show that cinnamon is effective in reducing mold growth in two out of the three treatment groups.

SMH113: Hand Washing and Glove Use

The purpose of the project was to test the effectiveness of washing hands before putting gloves on. According to the Association for Professionals in Infection Control and Epidemiology, gloves often have microscopic holes, making them less effective. If the gloves are not completely effective, then it poses a risk to the healthcare worker and their patient. The variable being tested was washing your hands as a preventative method for bacterial growth in addition to wearing gloves. The hypothesis is that hand washing will prevent bacterial growth because hand washing has been proven to decrease bacteria on hands. The importance of this is that if there is less bacteria on the hands then there is less opportunity for bacteria to seep through the microscopic holes in the gloves. The three treatments were control, hand sanitizer, and dial hand soap. Human participants were used, but all volunteered and signed human informed consent forms. The statistical analysis showed that the results did not support the hypothesis.

SMH114: Treating Diabetes through Epigenetic Modification of Immunity

Macrophages play a pivotal role in all kinds of immune responses, during which they are activated by a wide range of surface ligands and cytokines to acquire a continuum of functional states. The diverse differentiation status of macrophages has been referred as polarization, a dynamic and reversable process that modifies macrophage's functionality to a spectrum from proinflammatory to anti-inflammatory and is regulated by epigenetic regulation. Although T-lymphocyte-mediated autoimmune destruction of pancreatic beta-cells is the major pathological event in type 1 diabetes (T1D), macrophages are now known as a critical mediator since previous studies showed that anti-inflammatory macrophages can delay the onset of T1D. Reprogramming macrophage polarization is a promising strategy for designing novel therapies for human diseases but hasn't been used in T1D treatment. Here, we applied a novel technique that alters macrophage polarization from a proinflammatory subtype (predominant in T1D pancreas) toward an anti-inflammatory subtype using an adeno-associated virus (AAV) carrying shRNA for DNA methyl transferase 1 (DNMT1) under a macrophage-specific CD68 promoter that epigenetically alters macrophage polarization. Injection of these AAVs through pancreatic duct to pancreas not only prevented the development of diabetes in T1D-suscepitable mice, but also reversed hyperglycemia in early-onset ones. Moreover, bioinformatic analysis was performed to understand the underlying molecular basis. Since our intraductal infusion technology is similar to a non-surgical endoscopic procedure (ERCP) in humans, and since AAVs are used in most gene therapy clinical trials due to their relative safety, our study represents a potentially clinically translatable method to treat T1D patients.

SMH115: Macrophage School for Cancer Therapy

Success in treating cancer using antibodies or T lymphocyte-targeting strategies has been limited due to the complexity of the immune system. Recently, macrophages were found to play a central role in cancer immunomodulation and thus could be a promising therapeutic target. However, there is a lack of related knowledge and practical approaches for clinical application. The differentiation of macrophage status, known as macrophage polarization, appears as a dynamically changing spectrum, making it challenging to shape macrophages into an optimized polarization to prevent cancer development and initiation. In this study, an innovative strategy was created to treat various cancers with trained macrophages in a macrophage school. The research was carried out in Pdx1-Cre, Kras-mut, FoxO3-knockout mice, a model for pancreatic ductal adenocarcinoma (PDAC). Macrophages were isolated from the few noncancerous mice and then permanently labeled. These macrophages were then transplanted into new mice and anti-tumoral macrophages were obtained from the noncancerous mice as a macrophage school for four rounds. We observed a continuous decline in the rate of PDAC formation as a result of the serial transplantation of isolated macrophages from noncancerous mice. The PDAC-forming rate dropped from 90.5% to 76.5%, then to 52.2%, and finally to 42.1%. Additionally, a bioinformatics analysis of the phenotypic changes in macrophages revealed a progressive adjustment of their phenotype, optimizing their ability to benefit cancer treatment. This study provides new insights into the role of macrophage polarization in cancer immunomodulation and demonstrates a novel strategy for treating various cancers.

SMH116: Red light therapy and tissue regeneration

The Effects of Red Light Therapy on Tissue Regeneration LED Light therapy is a technique used to cause physical and emotional benefits to the human body. Red light therapy is believed to stimulate fibroblasts through mitochondrial modulation and other intracellular processes. Fibroblasts produce collagen matrices. Lumbricus terrestris, more commonly known as earthworms do not have fibroblasts like humans, cuticular collagen is produced and aligned similarly by the epidermal epithelial cells. The goal of this experiment is to determine the effects of red light therapy on tissue regeneration. I hypothesized that red light therapy will increase the rate of tissue regeneration of Lumbricus terrestris due to its effects on epidermal epithelial cells and the production of collagen. To perform this experiment, thirty were separated into two groups Three centimeters of the tail was then cut off on each of the earthworms. Everyday throughout the experiment, one group was exposed to a red light for thirty minutes. The other group was not exposed, and acted as a control. Every day the regrowth of the earthworms were measured to see how much of the tail regenerated. All of these steps were repeated for a second trial. Each trial was four days long. After a statistical analysis was performed, it was concluded that my data supported my hypothesis starting at day three for trial 1 and the trials combined and day four for trial 2.

SMH117: Bacterial Adhesion To Textiles Used In Athletic Wear

Athletes and individuals who exercise frequently are familiar with the stench associated with workout clothing or jerseys even after they have been washed. This odor is caused by lingering bacteria, of which most are found in our natural skin microbiota. Staphylococcus epidermidis is one of the main culprits. S. epidermidis has been found to produce a sour malodor, particularly in the underarm area, which is quite displeasing. This project attempts to test how well Staphylococcus epidermidis can stay adhered to different fabrics that we commonly use to make our activewear. The aim of this project is to determine which textiles are the most difficult for bacteria to stay adhered to. The results may be applicable to the design process and production of athletic wear or equipment. Various fabrics that are commonly used in sports wear were selected and disinfected. Each piece of fabric was then immersed in bacterial culture in nutrient broth prepared in a Petri dish. The dishes were then incubated. After incubation, the fabrics were rinsed. Using the contact plate method, the pieces of fabric were then stamped on an agar plate. Afterwards the plates were incubated and the amount of growth was measured. While experimentation is in progress, research has suggested that synthetic fabrics are likely to retain more bacteria than organic fabrics.

SMH118: The Effect of Electromagnetic Waves on DNA-Repair-Deficient S. cerevisiae

Baker's yeast, or S. cerevisiae, is a microorganism that is commonly used in science labs. It can be genetically engineered to be DNA-repair deficient, which means it can be easily damaged by factors such as diseases, temperature, or light waves. Some light waves that affect the growth of yeast are red light, blue light, and UV light. In my experiment, I investigated how these three types of light affected the growth of yeast colonies in both wild-type baker's yeast and DNA-repair deficient mutant yeast. I prepared serial dilution of both wild-type and mutant yeast, and I put five Petri dishes of each under a red light lamp, a blue light lamp, a UV lamp, and a control condition covered with aluminum foil. After letting the yeast grow, I counted the number of colonies in each condition and ran statistical tests on the numbers. My results showed that within the wild-type yeast condition, the UV light condition had the least amount of colonies, the red light condition had the second-least number of colonies, and the blue light condition had the most number of colonies. However, within the mutant yeast condition, the results were not statistically significant.

SMH119: Natural Antibiotics

Please visit student's exhibit for abstract

SMH120: Conquering Fungi with Natural Remedies

While fungicides effectively control plant diseases in crops, certain studies have reported they negatively impact plant physiology and photosynthesis. C. globosum, a cellulose-digesting fungus found in soil, plant debris, waste, and other indoor materials is considered one of the most prevalent fungi in the world. The main concern with C. globosum is that it produces cytotoxins, which are known to lead to severe health problems in humans. C. globosum can only be removed if the surface it's growing on is removed, making it difficult to get rid of. This experiment will focus on finding a more natural way to eliminate this fungus with a long-term goal of moving to other fungi that are known to infect crops. To illustrate, eleven samples of C. globosum were plated and incubated until fully mature before administering the first treatment. The treatments include ginger root powder, ginseng root powder, turmeric root powder, Ceylon cinnamon, eucalyptus essential oil, oregano essential oil, virgin coconut oil, raw honey, apple cider vinegar, and garlic, each selected for their demonstrated antifungal properties. The treatments are applied to fungal samples once a week, and while results are still in the early stages, it appears that oregano oil shows potential for fungal spore inhibition while raw honey, ginseng, and ginger appear to lead to increased growth. Statistical analysis via chi-square and final conclusions are currently impending at this time.

SMH121: OPMR1 Gene in Mice Oral Cancer Cell Lines

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SMH122: Bacterial Growth in Water

I have always wondered if my water sitting out is still fine to drink. Warm water is a great place for bacteria to breed, so does your water have a bunch of bacteria growing in there? This experiment was made to see the bacteria growth in water. Scientists have been researching bacteria growth for over decades. Characteristics of bacteria growth have been compared and methods have been altered. I wanted to see how fast bacteria would grow in a bottle of water sitting in room temp. This experiment will also help me understand how often I should wash my own water bottle. If people know how much and fast bacteria grow, then they can make assumptions. To do this, I will get my different types of water and inoculate them using the serial dilution method. The bacteria I will put in, is going to represent the bacteria that transfers to your water after you take a sip. I am using E Coli for my bacteria because it is commonly found in water and in your mouth. I am using the serial dilution method for a better visual of the bacteria growth. I let my water sit at room temperature for one day then I will take water and put it onto my agar plate using the plate count method. I do this everyday for about a week and see how the bacteria grows. I will conclude the rate of bacteria growth after a measure of how much bacteria grew.

SMH123: Effects of Methionine on Osteoblast Differentiation

Background: Research has shown that fasting results in beneficial physiological adaptations. For instance, studies have linked fasting to positive effects on chronic conditions such as obesity, diabetes, and cancer. However, fasting can also lead to negative health consequences, such as bone loss. A recent study investigating the effects of fasting on bone health in healthy adults revealed that P1NP circulating levels (bone formation marker) significantly decreased as fasting progressed. Interestingly, as P1NP levels decreased, methionine levels significantly increased, suggesting a potential relationship. But how methionine impacts bone formation is not fully understood. The aim of this study was to test the hypothesis that excess methionine impairs osteoblast (bone-forming cells) differentiation. Methods: A human pre-osteoblast cell line (hFOB1.19) was used. Cells were incubated at 39.5%u02DAC to initiate differentiation with exposure to 4 different levels of methionine during 16 days of differentiation: 1) no methionine; 2) 20 µmol of methionine (control); 3) 100 µmol of methionine; and 4) 500 µmol of methionine. Media was changed every 3 days, with treatment remaining constant. Following 16 days, mineralization levels were assessed using Alizarin Red. Results: No methionine treatment resulted in significantly less mineralization compared to normal levels of methionine (20 µmol) (no methionine: 0.0141 ± 0.00182 mM; 20 µmol methionine: 0.0762 ± 0.00477 mM, $p < 0.01$). High doses of methionine (100 and 500 µmol) induced less mineralization than the 20 µmol dose (methionine 100 µmol: 0.0572 ± 0.00297 mM; methionine 500 µmol: 0.0474 ± 0.00545 mM, $p < 0.01$). Conclusion: Methionine seems to play a significant role in osteoblast differentiation; for osteoblasts to differentiate, optimal levels of methionine are needed. It seems that osteoblasts do not differentiate in the absence of methionine, but excess methionine may also impair mineralization. Additional studies will be necessary to confirm this effect and to determine the mechanism of how methionine levels regulate bone formation.

SMH124: Decoding the Mechanisms of Gut Bacterial Metabolites for Colorectal Cancer Treatment

Colorectal cancer (CRC) is a leading cause of cancer-related deaths, and gut bacteria play a crucial role in its pathogenesis. Gut bacteria metabolize dietary substrates to produce various metabolites that can either promote or suppress CRC tumorigenesis. While many studies have focused on metabolites that promote CRC, less attention has been spent on studying metabolites that exhibit anti-cancer activity. Discovering such compounds could lead to novel therapeutics. In this study, Fusobacterium nucleatum and Escherichia coli supernatants that are high in ciliatine, a representative phosphonate, were shown to inhibit the growth of COLO205 cells, a CRC cell line. To further investigate the potential anti-cancer effects of ciliatine in CRC, ciliatine solutions at different concentrations were applied directly to several CRC cell lines (COLO205, HCT116, HCT15, and KM20L2) and the cell viability, number and morphology, were examined. Ciliatine elicited anti-growth and proliferative effects in all four CRC cells but had no effect on the control human umbilical vein endothelial cells. Further mechanistic studies using flow cytometry revealed that ciliatine induced CRC cell growth inhibition through apoptosis (programmed cell death) but not necrosis and that the cells were stopped at the sub-G0/G1 phase. Structural modeling analysis suggested that ciliatine may inhibit CRC cell growth by binding to PPAR%u03B4. To my knowledge, this is the first time that ciliatine was discovered as an anti-cancer agent for CRC, which could potentially pave the way for new strategies for CRC management by modulating gut bacteria populations, incorporating ciliatine into dietary supplements, or developing ciliatine-based drugs.

SMH125: Predicting Postoperative Lung Cancer Recurrence Survival using Cox Proportional Hazards Regression and Machine Learning

Surgical resection remains the optimal treatment for early-stage lung cancer. However, the recurrence rate after surgery is unacceptably high (30%-50%). Despite the significant efforts in this regard, it remains elusive to accurately predict the likelihood and timing of recurrence. In this study, we propose to predict postoperative recurrence by identifying novel image biomarkers from preoperative chest CT scans. A cohort of 309 patients was selected from 512 non-small cell lung cancer patients who underwent lung resection. We used Cox proportional hazard regression analysis to identify risk factors associated with lung cancer recurrence and compared its performance with machine learning (ML) methods in predicting lung cancer recurrence. The goal is to improve our ability to predict the risk and time of a seemingly cured cancer to come back and facilitate personalized surveillance strategies and thus minimize lung cancer recurrence. The Cox hazard analyses showed that surgical procedure, TNM staging, lymph node involvement, body composition, and tumor characteristics are important determinants of the risk of both local/regional and distant recurrence for recurrence-free survival (RFS) and overall survival (OS). ML-based approaches and Cox models exhibited similar performance with an area under the receiver operative characteristic (ROC) curve (AUC) ranging from 0.75-0.77. Our promising results demonstrated the feasibility for predicting postoperative lung cancer recurrence and survival time using preoperative chest CT scans. To fully validate its performance and bring it into clinical practice for the treatment of lung cancer, further validation is needed through external validation using a larger cohort from multiple sites.

SMH126: Spinach as a Substitute of Insulin

Diabetes is a condition where the body has higher than normal glucose levels. Insulin injections are often used to control glucose levels in the body. Multiple studies have suggested the use of insulin-like plant proteins as a potential alternative to the insulin we use today. Many benefits come along with the use of an alternative such as a reduction of the cost of production by about 10% and a reduction in the risk of pathogens entering the bloodstream. What a consumer uses today is either biosynthetic or animal sourced. Biosynthetic insulin is produced by the insertion of a gene that codes for an insulin protein into bacteria. Animal sourced insulin is produced through the extraction of the hormone from the pancreases of animals and then the purification of the extract. A 1987 study showed promising results of spinach as an alternative to insulin. In this project, I am testing whether spinach would be an appropriate substitute for the extracted insulin. In order to test this, I am using the Similar-Structure, Similar-Property Principle, which states that similar molecules exhibit similar properties and a similar structure. Some properties I am testing are water solubility, molecular mass, and polarity. To extract proteins from spinach, I am using a phenol-chloroform extraction. Once data is collected, I am comparing the properties of the spinach proteins to the properties of the traditional insulin proteins and will use the principle to conclude if spinach is a promising alternative to the insulin found today.

SMH127: The Effectiveness of Mechanical vs Chemical Cleaners

This experiment was conducted to compare the effectiveness of killing E. Coli bacteria using different disinfectant strategies; mechanical versus chemical. The two types of disinfectants used include Norwex microfiber cloths representing the mechanical cleaner and Clean Cut disinfectant wipes representing chemical cleaners. Using aseptic technique throughout the whole process, I started off my experiment by swabbing E. Coli bacteria on a surface and wiped each section with their respective cleaners and plated and incubated the product. A control was also included to show growth if not disinfected at all.

SMH128: Cyclin E amplification or overexpression in High Grade Serous Ovarian Carcinomas (HGSOC) increases DNA damage

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SMH129: A Machine Learning Approach to Predict Changes in Psychological Stress Levels Based on Experimental and Demographic Factors

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SMH130: The Differentiation of T-Cell Receptors by their Viabilities and the Sensitization of Target Leukemia Cells with the usage of IFN-%u03B3

Leukemia is a cancer of the blood characterized by the overproduction of mutated leukocytes. Stem cell transplant is the treatment is prominent, however, about 58% of patients die of a recurrence of leukemia post-transplant. To combat this issue, introducing ways to sensitize target leukemia cells is necessary. The protein CD69 and IL-2 act as an activation marker for T-cells. Both CD69 and IL-2 are presented when a T-cell receptor (TCR) is with target leukemia cells. The amount of IL-2 and CD69 determines the affinity of the TCR. Priming the target leukemia cells with IFN-%u03B3 was believed to enhance the TCR's action resulting in higher immunogenicity and a stronger immune cell reaction. An Enzyme-Linked Immunosorbent Spot test was used to determine the presence of IL-2 and CD69. The first test's goal was to find if TCR 12 or TCR 539 had a higher affinity. The second ELISpot (using the highest affinity TCR) tested the effects of IFN-%u03B3 target cell sensitization for HA-1 TCR recognition and activation. The first ELISpot proved that TCR 539 had a higher affinity on target cells than TCR 12. IFN-%u03B3 at a concentration of 1µg per mL increased the immunogenicity with THP-1 but did not seem to have a large effect on T2. The study proves that IFN-%u03B3 can sensitize target leukemia cells to allow for better activation and initiation of an anti-cancer immune response.

SMH131: The Effect of Disinfectants on Bacteria

Please visit student's exhibit for abstract

SMH132: Determining the Best Chemotherapy for TACE Therapy

TACE therapy or transarterial chemoembolization is a treatment for unresectable liver where chemotherapy and an embolizing agent are injected through a catheter to combat and block off blood flow to the tumor directly. A lack studies determining the best chemotherapy has caused prescriptions of chemotherapy that may not be most beneficial for the patient. By collecting and analyzing data on patients who have received TACE therapy, the optimal chemotherapy can be discerned. Introduction The three different types of chemotherapy used in TACE therapy, streptozocin, doxorubicin or cisplatin, may cause different lengths of overall survival. The goal of this study is to determine which chemotherapy best complements TACE therapy. Methods Data were collected on multiple, demographic, disease-related, and treatment-related variables from patients older than 18 with unresectable liver metastases treated with TACE using streptozocin, doxorubicin, or cisplatin, from 2002 to 2022. Overall survival was measured from the time of diagnosis, metastatic disease, and the time of the start of TACE treatments. These along with univariable and multivariable analysis results were used to compare each chemotherapy. Results The P-value for the overall survival from diagnosis was 0.939, from metastases diagnosis was 0.639, and from TACE start was 0.210. Because none of the values were

SMH133: Inducing Neurogenesis in Dental Pulp Stem Cells Via a Dynamic Magnetic Field

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SMH134: Looking into the Microbiome of Oakland

I aimed to research what species of bacteria can be found in oakland. Cities are where some of the most diverse microbiomes form. Densely populated cities where people from all over the country and world gather are where we can observe millions of different microbes living together. Tracking where certain bacterias come from allows us to identify where and how some diseases spread. This research can be applied when looking at biodiversity of different cities or states and how different infections and diseases spread around them. To test what species could be found in oakalnd I took samples of the outside doorknobs of the 5 most popular restaurants in oakland, choosing 9 colonies from these plates to sequence using PCR specific locus application. As well as conducting a gram stain to identify the membrane structure and shape of the bacteria. The rational for choosing door knobs is that many people are constantly touching them, restaurant especially because someone may not wash their hands before eating. Than whatever bacteria that may have come in contact with their hands may be able to enter the body. Using blood agar plates to grow my bacteria. Letting those incubate at 37.2°C over 24 hours. The data indicated the presents of fungi and pseudomonas species in Oakland. In conclusion various different types of bacteria are present in Oakland.

SMH135: Synergistic effect of Emodin and Doxorubicin on human colon cancer cell line COLO320

Emodin (EMD) is a chemical found in plants used in Chinese medicine. Studies have shown that it has anticancer effects, like inducing apoptosis and preventing metastasis. Doxorubicin (DOX) is a drug commonly used in the treatment of breast cancer, causing cell death through both necrosis and apoptosis. However, most colorectal cancers (CRC) are not sensitive to DOX monotherapy. I investigated the effects of EMD, DOX, and EMD + DOX on COLO-320DM CRC cells to test their potential synergistic effect. The EMD + DOX combination treatment showed a significant impact on cell viability at concentrations orders of magnitude lower than EMD or DOX alone. In addition, necrosis was not a key contributor to cell death, while apoptosis was a main contributor to cell death in all drugs tested. These findings show that the combination treatment's were significantly increased as opposed to monotherapy.

SMH136: Evaluation of How SNORD-67 Promotes Metastases

Small nucleolar RNAs (snoRNAs) are a class of non-coding RNAs that lead to RNA modification. There is increasing evidence that snoRNAs have roles in promoting cancer. Using a mouse model of breast cancer, previous work in the lab demonstrated that the snoRNA SNORD67 may be important for cancer metastasis to lymph nodes. A SNORD67 knockout was generated using CRISPR/Cas9 gene editing in 4T1 mouse breast cancer cells. Knockdown of SNORD67 decreased cancer cell proliferation and tumorigenesis in vitro. 4T1 wild-type and SNORD67 knockout cells were injected into the mammary fat pad of mice to form breast tumors. We then quantified metastasis to lymph nodes and to the lung. Metastasis to the lung was quantified using two different methods, quantitative RT-PCR (qPCR) and immunohistochemistry (IHC). While there was a statistically significant decrease in lung metastases in both SNORD67 knockout cell lines when measured by IHC, only one knockout cell line showed a statistically significant decrease in lung metastases when measured by qPCR. These results show that qPCR is a more sensitive method to detect lung metastasis than immunohistochemistry. Because the known function of SNORD67 is to facilitate the methylation of the RNA U6, future directions include determining whether methylation is necessary for the cancer phenotype of SNORD67 knockouts. We will measure proliferation and tumorigenesis in wild-type, SNORD67 knockout, and SNORD67 knockout cells that overexpress mutant SNORD67 that cannot methylate U6. We will measure methylation of U6 using a method called reverse transcription at low deoxy-ribonucleoside phosphate followed by PCR (RTL-P). These experiments will help us to understand the mechanisms of how SNORD67 promotes metastasis.

SMH137: Effects of Melatonin on Microbial Survivorship

Melatonin is a common sleep aid for numerous people. I is claimed to be safe, though effects on human microflora have yet to be investigated. Various concentrations of melatonin will be exposed to a common internal Gram - symbiont, E. coli. as well as a common external Gram + symbiont. Survivorship will be measured by resulting colonies on LB agar.

SMH138: The Effect of Food Intake on Body Temperature

The purpose of this experiment is to determine if food intake effects body temperature. Maintaining a stable body temperature within normal ranges assists in optimizing bodily functions. Therefore, minimizing environmental factors within the hospital setting may result in unnecessary body temperature fluctuations. Participants in this study were expected to take their temperature before and after a meal at 30 and 60 minute intervals. Data is in the process of being analyzed. Currently, there were 3 sets of data where the temperature went down directly after eating and then back to normal at the 60 minute interval, and then there were 5 that went up then back to normal at the 60 minute interval.

SMH139: Using Extracellular Vesicles (EVs) to Protect Brain Endothelial Cell Death During Ischemic Stroke

During an ischemic stroke, the blockage of arteries leading to the brain causes a lack of oxygen, glucose, and blood. This leads to cell death of brain endothelial cells (BEC) in the Blood Brain Barrier: a semipermeable membrane that surrounds the brain and protects it from foreign substances. BEC death induces weakening of the Blood Brain Barrier, which allows for harmful toxins that are normally regulated to enter the brain and cause severe damage to the sensitive neurons and brain cells within. This project proposes the use of Extracellular Vesicles (EVs), vesicles derived from BECs, to deliver mitochondria and the protein HSP27 (a protein naturally found in muscle cells that strengthens the cell membrane) to reduce BEC death and strengthen the Blood Brain Barrier's structural integrity. Using samples of untreated cells, cells treated with small EVs, and cells treated with medium/large EVs, the effect of transferred mitochondria and the membrane strength due to HSP27 was measured. In addition, measures of cytocompatibility were taken to determine whether EVs are safe to use in vivo. It was found that medium/large EVs transferred their mitochondrial load more effectively than small EVs due to a significant increase of ATP production measured through an ATP Assay. Furthermore, both types of EVs similarly strengthened BEC membranes, which was shown by the decreased permeability of a molecular tracer (Dextran). This double faceted strategy utilizing both mitochondria and HSP27 shows promise in reducing lasting neurological damage during an ischemic stroke.

SMH140: Negative stimuli effect on habitation of yellow slime mold

My project is on the the negative stimuli affecting the yellow slime mold. I will approach this project by having the slime mold adapt to a change faster than expected. The mold will adapt to change by extending itself across a substance the slime mold is known to dislike. The slime mold through this while being under threat of being dried out with a hair dryer.

SMH141: Novel Drug Combination Treatments for Small Cell Lung Cancer

Small cell lung cancer (SCLC) is an aggressive form of lung cancer that accounts for 15% of all lung cancer cases. Heavily associated with smoking, small cell lung cancer generally has a poor prognosis and usually only detected in the later stages when it has already metastasized, making it difficult to treat effectively. While the initial treatments are often effective, the cancer almost always returns and becomes resistant to previous treatment. Single drug treatments are rarely effective, and the testing of new drug treatments and combinations are critical in the search of effective treatments. Our project focused on identifying possible drug combinations for the treatment of SCLC, using small cell DMS273 lung cancer cells. Our preliminary data demonstrated that SCLCs are sensitive to Polo-like kinase 1 (PLK1) inhibitors. Following IC50 determination of onvansertib (PLK1i) and four standard chemotherapeutic agents (AZD6738, BAY1895344, lurbinectedin, paclitaxel), the agents were combined and potential synergies were identified using Compusyn. The combination of onvansertib and paclitaxel showed the most synergy. To investigate the mechanism of action of onvansertib and paclitaxel, cells were exposed to the agents for 24 hr and then processed for immunoblot analysis. We observed rapid inhibition of PLK1 followed by stalling of the cell cycle at the G2/M phase. The combination resulted in enhanced PARP cleavage, indicating that the cells underwent apoptosis. Onvansertib and paclitaxel are synergistic and the combination treatment was able to induce apoptosis in SCLC cells. Future studies will evaluate this combination in our in vivo animal models.

SMH142: Using a Molecular Docking Method to Screen FDA Approved Drugs for Their Potential Use as a PI3K Inhibitor in Breast Cancer Treatment

Breast cancer is the most commonly diagnosed cancer in the world, and one of the leading causes of death by cancer, accounting for more than a fifth of cancer deaths globally. Research has shown that mutations in the PIK3CA gene are responsible for the growth of cancer cells by causing the PI3K enzyme to become overactive. Anti-breast cancer drugs such as Alpelisib, an inhibitor of PIK3CA, are effective. However, reports show that these medications can cause side effects including liver damage and infertility. This study used a Chimera/Vina software to assess the binding affinity, which is used for drug identification in pharmaceutical drug development, between the disease target gene and a drug based on their molecular structures. A series of previously approved anti-tumor drugs were evaluated for their binding affinities with the PIK3CA gene mutation. Individual docking between each drug and gene were carried out using the software, and docking scores were obtained and ranked in comparison to the control, Alpelisib. The more negative docking score represents a higher binding affinity, as less energy is required for target gene binding, to elicit pharmacological effect. Out of the six drugs evaluated, two had more negative scores than Alpelisib, which had a docking score at -6.3. Selpercatinib scored a -6.7, and Entrectinib, at -7.8. Based on this virtual screening, Selpercatinib and Entrectinib have demonstrated potential for further experimental evaluation. If further confirmed, these two lung cancer drugs could be repurposed for breast cancer treatment.

SMH143: The Effects of Mutation and Texture on Biofilm Formation in Pseudomonas fluorescens

Th communication of certain species of bacteria can result in the creation of a biofilm, a protective shield made of carbohydrates, proteins, and DNA that is often antibiotic-resistant. Biofilm formation by pathogenic bacteria on implanted medical devices causes major morbidity and mortality among patients and leads to billions of dollars in healthcare costs. The resiliency of the biofilm makes it capable of causing a broad range of chronic diseases or problematic conditions, as well as persisting over time. As a result, approaches to prevent or treat biofilms are in urgent need. This project examines how the introduction of different strains of Pseudomonas fluorescens and texture impact the growth of biofilms. The bacterial strains of ancestral, lacZ+, and wspF mutations, as well as smooth and grooved aluminum strips were selected. The ancestral colonies when grown in isolation appeared to have the relatively lowest colony number, while also appearing to have the largest colony size. In the lacZ+/Ancestral competition assays, the lacZ+ colonies had significantly higher colony counts, indicating that potentially increased metabolism aids in the growth of biofilms. In the wspF/lacZ+ competition assays, the lacZ+ colonies had slightly greater colony counts, although it is important to note that some of the wspF colonies appeared to still be ancestral. It is also of significance that there was a high presence of mutations, specifically of the wrinkly phenotype even in non-wspF strains, which suggests that Wrinkly Spreader mutants have a competitive advantage over the ancestral round colonies. There were significant increases in growth across all trials in all cultures/competition assays on the textured strips, suggesting that texture/surface area is critical for further biofilm formation. These findings suggest that certain bacterial traits, such as having increased metabolism and being a Wrinkly Spreader mutant, increase competitiveness and that surfaces that decrease surface adhesion can comparatively diminish biofilm formation.

SMH144: Difference Between Sunblock and Sunscreen on Algal Growth

This project tested the different effects of the two different types of active ingredient bases on algae, to determine how much if at all they effect the algae's growth. The two different bases are chemical and physical, each containing different active ingredients. Chemical active ingredients are the bases of sunscreens, and physical active ingredients are the bases of Sunblock.

SMH145: Using HepG2 cell in vitro model to investigate non-invasive ultra-sensitive diagnosis of nonalcoholic fatty liver disease (NAFLD)

Nonalcoholic fatty liver disease (NAFLD) is the most common liver disease, with a global prevalence of 32.4%. Approximately 10 to 30% of individuals with NAFLD can develop nonalcoholic steatohepatitis (NASH), which can progress to fibrosis or cirrhosis and eventually hepatocellular carcinoma if detected late. The standard practice for differentiating NASH from simple steatosis is liver biopsy, which is invasive, costly, limited by sampling errors, and impossible for all patients. Therefore, it is clinically significant to develop accurate and cost-effective non-invasive diagnostic strategies for detecting NASH among NAFLD patients early. The study demonstrates a potential non-invasive ultra-sensitive diagnostic method using the Erenna Immunoassay System powered by Single-Molecule Counting (SMC%u2122) technology with CK-18 serum level as a biomarker. HepG2 cells were treated with oleic acid (OA) at various concentrations ranging from 0 (control) to 1.6 mmol/l to induce lipid droplet accumulation and cell death to stimulate NAFLD progression in vitro. The Erenna Immunoassay System was used to determine CK-18 concentration in the HepG2 cell supernatant from each NAFLD model. The conventional ELISA was performed to compare method sensitivity. While the ELISA could not accurately measure lactate dehydrogenase (LDH) concentrations when OA concentration was lower than 0.1 mmol/l, the CK-18 Erenna® immunoassay yielded increasing values as the OA concentration increased, suggesting superior sensitivity. For future studies, clinical serum samples should be tested in place of supernatant to evaluate method sensitivity in clinical scenarios. The study offered researchers unprecedented insight into developing a new non-invasive ultra-sensitive diagnostic method for the early detection of NASH.

SMH146: The effect of artery diameter on blood flow rate

Please visit student's exhibit for abstract

SMH147: Do Certain Foods Affect Heart Rate? Whole Foods vs Processed Foods

Please visit student's exhibit for abstract

SMH148: The Effects of Natural Antioxidants on Food Additives

Food additives are ubiquitous in today's society as it is seen as a tool to reach food security. They are used to improve taste, appearance, functionality, shelf life, and nutrition. However, many food additives are noted for their side effects on health as well as impact on the environment. Food preservatives are added to food primarily to extend the shelf life. Antioxidants are considered to counteract or reduce oxidative stress in live organisms. Therefore, would ingesting antioxidants after or with food counteract the harmful effects of food additives? Daphnia has been considered as a model species in toxicological studies. It's short life cycle also makes it a good candidate for biological experiments. In this experiment, daphnia will be exposed to a food preservative and an anti-oxidant to observe their effects on daphnia heart rate. The Objective of this study is to find out whether green tea can reverse the oxidative stress caused by sodium benzoate food preservative. Heartbeats per minute are used to collect the data. The data analysis will be available on the fair day.

SMH149: Bioluminescence at Its Brightest

Please visit student's exhibit for abstract

SMH150: Sex-Based Differences n Environmental Regulation of Macrophage Mediated Cancer Immunity

Please visit student's exhibit for abstract

SMH151: Dragon's Blood and Wound Healing

Natural remedies, even with the prevalent existence of modern medicine, are utilized in many communities around the world to cure illness, disease, and wounds. A tree sap found in northwestern South America and many other parts of the world is a natural source of medicine that treats gastritis, accelerates wound healing, treats bruising, and alleviates AIDS-associated diarrhea, among many other uses. Its name, Dragon's Blood, comes from its red, blood-like appearance. The most common genus of Dragon's Blood, Croton lecheri, found in South America, was evaluated for its antibacterial properties. The three bacteria used in this experiment were E.coli, P.fluorescens, and B.thuringiensis. These bacteria all have association with infections of wounds (such as ocular wounds) and the blood. Additionally, different concentrations of Dragon's Blood were compared (100%, 50%, 25%, 10%). A negative control (sterile water) and positive control (Kanamycin) were included. Three disks dipped in each respective solution were organized on an LB Agar plate spread with 1 of the 3 bacteria. Each disk represented a trial. Overall, it was found that E.coli had the most resistance to Dragon's Blood, followed by P.fluorescens, only affected by 100% Dragon's Blood. B.thuringiensis was affected most, with a Zone of Inhibition (ZoI) observed at all concentrations. However, based upon average ZoI, Kanamycin affected the bacteria more than Dragon's Blood did. Though less than that of an antibiotic, Dragon's Blood had an observed antibacterial effect.

SMH152: Automation of the Morphological Analysis of Stem Cells with AI

Newer medical technologies, such as induced pluripotent stem cells (iPSCs) have brought revolutions in healthcare. They allow for researchers and physicians to develop treatments for patients in new ways. However, much is yet to be discovered concerning iPSCs, especially their differentiation patterns. This study focuses on the effectiveness and feasibility of using artificial intelligence, machine learning, and Python to automate the morphological analysis of stem cell samples. The goal is to remove a certain amount of bias and assist researchers when judging the development and differentiation of stem cells. Beginning with the images, I used Python 3.9.16 with Scikit-learn, NumPy, OpenCv2, ND2Reader, Pillow, csv, and all dependencies to process and store data of all images. Then feeding this data into multiple different machine learning models allowed me to test the ability of these models to accurately classify images into categories representing their stages of development. My research found that a Multi-Layer Perceptron, a type of neural network, was most effective at classifying the images based on characteristics. It had an average score of 0.775 and a standard deviation of 0.025. These results were statistically significant ($p=0.02$), suggesting that this approach is feasible, although my results imply a larger dataset would be required to properly implement this method. This application of machine learning could also eventually emerge as a tool for other researchers.

SMH153: A Novel Approach to the Development of a Diabetes Drug

Type 2 diabetes (T2D) is a common and untreatable disease that can affect many organs and lead to life-threatening complications. At the genomic level, there are multiple factors challenging the further development of druggable targets including uncorrelated gene expressions in surrogate mouse models and human pancreatic islets. Thus, the current study is to overcome those challenges by analyzing glucose uptake function levels guided through tertiary protein targets to develop a potential drug target. The Glut4 structure was utilized to identify the structural integration with known other transmembrane receptor ligands. In this current study, nicotine and dopamine are used to explore the novel interaction for (Glut4) protein-(Nicotine/Dopamine) ligand confirmation because studies have shown nicotine as a risk factor for developing T2D and at the same time dopamine may help on the glucose uptake into cells. For this analysis protein and ligands structure were acquired from an online database and molecular docking was done via Auto Dock Vina. Hydrophobic and hydrogen bonding interaction was identified by Lig Plot. Novel findings: Nicotine and Dopamine are docked in the same pocket region in Glut4 (serine 153 residue interacting with both). Haloperidol (Dopamine Receptor (DR) antagonist, and a clinically used antipsychotic drug) has a similar docking pocket region as nicotine in Glut4 and Bromocriptine (DR agonist and a clinically used in Parkinson's disease) directly interacts with Glut4. This reveals a possible new mechanism for combating diabetes. This report emphasizes that for the first time Glut4 can interact with nicotine, dopamine, Haloperidol, and Bromocriptine.

SMH154: The Effect of Estradiol on MDA-MB-231 Cancer Cells

Estradiol(E2) has always been a controversial topic to talk about because many women's choses to use E2 for different purposes inside their body. I wanted to find out how much estradiol can affect our body and if the effects of E2 can negatively affect us. To do that, I used the T75 culture flask of MDA-MB-231 cancer cells line which I then trypsinized, treated it with media, and added estradiol. Right after that, I incubate the flasks for 1 whole day to give the cells enough time to grow. Then, for the next two days, I used the Evos microscope to count the numbers of cells for each sample. After those two days, I have the ANOVA but I still want to check the result with the Dunnett's Test. Based on the results gathered from the ANOVA and Dunnett's statistical analyses, it appears that the null hypothesis can be rejected for Day 1. However, it failed to reject the null for the exposure of Day 2, no significant effect observed.

SMH155: The Effect of Acidic and Basic Topicals on S. Epidermidis

Staphylococcus epidermidis bacteria plays a role in the development of acne, and disorders that affect the outer skin barrier are more likely to be impacted by imbalanced pH levels. My experiment examines the impact of skincare products with varying pH values on the growth of S. epidermidis. I tested 3 products, a facial cleanser, astringent and lotion, and a name brand and generic brand of each. I created liquid infusions of each product with a sterile solution, measured the pH of each, then added a measured volume of the bacteria. Then, the infusions were pipetted onto sterile plates, three trials per product alongside a control of no product, and incubated for 4 days. At the end of incubation, the amount of colonies present were measured, and the name brand facial cleanser was most effective in killing S. epidermidis and had a lower pH value than the other products, indicating a correlation between pH level and bacterial growth.

SMH156: A model of Spinal Disc Bulging using Slime

The spine is a central support structure and your spine has 3 natural curves. I want to show how disc bulging in your spine occurs by using 3 different types of slime and I will use different weights to test the strength of the 3 modeled discs. Experimentation is ongoing and results will be provided at the science fair .

SMH157: Carcinogens Produced during Grilling

Chemicals such as Heterocyclic amines and polycyclic aromatic hydrocarbons form when cooking meat at high temperatures. I will test if they are carcinogenic by using compounds that form on the meat to see if it kills the bacteria e-coli on a plate. I will swab plates with E.Coli. Then put meat on the dish after swabbing to see if there is a change in the amount of bacteria on the plate and let it sit for two days and see if there is space between the meat and bacteria. Experimentation is ongoing and results will be provided at the science fair

SMH158: Which medicine works the best?

Gastric acid is formed in the stomach lining and helps our bodies absorb the nutrients needed from what we eat through proper digestion. I chose to experiment on how soda affects gastric acid and which remedies can help relieve the discomfort built up from the carbon dioxide the stomach creates. When I drink Pepsi I would immediately have to burp and never understood the reasoning behind that. I will add the different sodas into my simulated gastric acid and test the COo2 and pHPh of the solution after it's combined with soda and the selected remedy. Experimentation is ongoing and results will be provided at the science fair

SMH159: How effective are natural cleaners?

Bactria has been on earth for millions of years and life wouldn't even be the same without them, but there are hurtful and helpful bacteria. Bacteria is a unicellular organism meaning an organism that consists of a single cell, unlike a multicellular organism that consists of multiple cells. There are bacteria that cause infections such as Strep throat. A way to protect yourself and others from bacteria you should wash your hands and use good cleaning productions on objects. I will be testing how different cleaners work. Experimentation is ongoing and results will be provided at the science fair.

SMH160: The Effect of Inositol on Drosophila Melanogaster

According to the CDC, up to 5 million American women suffer from Polycystic Ovarian Syndrome (PCOS). One of the key symptoms of PCOS is insulin resistance. The most common treatment for insulin resistance is the prescribed medication metformin. A non-traditional method for addressing insulin resistance is usage of the supplement inositol. But while metformin is regulated by the FDA, inositol is not. The purpose of my experiment is to determine what effects inositol has on Drosophila melanogaster. Through diet, I give the Drosophila insulin resistance. I will then give a group of Drosophila medium with inositol. My control group will not receive inositol. I will then test differences between the Drosophila that did and did not receive inositol. I will then analyze my data and determine how inositol impacts Drosophila. The results of my experiment will be available on competition day.

SMH300: Comparing microbiomes of people with a vegan diet vs people with a non vegan diet

Please visit student's exhibit for abstract

SMH301: What Is The Right Number Of Conformers for Pharmacophore Virtual Drug Screening (and How Should They be Generated)?

Please visit student's exhibit for abstract

SMH302: An machine learning-enabled ECG algorithm for the identification of patients with unknown congenital heart conditions during sinus rhythm: a retrospective analysis of outcome prediction

Sudden Cardiac Arrest is the leading cause of death in young athletes, when it occurs it often kills with a mortality rate of >88%. Nearly 365,000 SCA's occur each year in the United States. This event is often triggered by an electrical malfunction resulting from underlying cardiac disease states such as WPW Syndrome, Hypertrophic Cardiomyopathy, Ion Channelopathies, and other congenital and acquired disease states. In this project we propose a data model using publicly available EKG datasets(PTB-XL) in order to apply neural networks to a Electrocardiogram device in the future.

SMH303: Respiration of Yeast at Different Temperatures

Please visit student's exhibit for abstract

Pittsburgh Regional SCIENCE & ENGINEERING Fair
Powered by CARNEGIE SCIENCE CENTER

84th Pittsburgh Regional Science & Engineering Fair

Senior Division

Physics and Astronomy (SPA)

Student Project Abstracts

March 29, 2023

Notes to Judges

Students prepare Abstracts limited to 100 words that include the following:

- Purpose of the experiment
- Procedures used
- Data
- Conclusions
- Possible research applications
- Minimal reference to previous work
- For continuation projects, the abstract should focus on work done since the last PRSEF
- Should not include: a) acknowledgments, or b) work or procedures done by the mentor

Many students continue their research after the Abstract is submitted, and therefore the Abstract may not fully represent the Project.

Abstracts are available to the Judges prior to the Science Fair as an aid in pre-screening the Projects. Judging is to be based on the actual Project as presented by the student.

Project Numbers are assigned as XYYABC

- X: S – Senior Division (9th through 12th grade)
- YY: Category Name
  - BS – Behavioral and Social Science
  - BI – Biology
  - CH – Chemistry
  - CM – Computer Science and Math
  - EE – Earth and Environment
  - ER – Engineering/Robotics
  - MH – Medicine/Health/Microbiology
  - PA – Physics and Astronomy
- ABC: Project number
  - 1xx or 2xx – Individual student projects
  - 3xx – Team projects (2 or 3 students)

Physics and Astronomy (SPA)

SPA100: Determining Orbital Parameters of Near-Earth Object 2016WG

Near-Earth objects are Solar System objects that can come within 1.3 astronomical units of Earth. Because of the close distances at which these objects can orbit, they pose a threat to Earth. Because of this, it is important to characterize and verify the orbits of these objects so that their future positions can be calculated. The goal of this study was to determine the 6 orbital elements of near-Earth asteroid 2016 WG, and to determine if and how they have changed from Jet Propulsion Laboratory's (JPL) initial calculations made in 2016. Images were collected using the 1-meter telescope at McDonald Observatory on December 28th and 31st, 2022, and January 3rd, 2023. The images were then plate solved, and the celestial coordinates of the asteroid in each image were recorded. Code that used the Method of Gauss to determine the orbital elements was then written in Python. The orbital elements were calculated to be: eccentricity = 0.74213, semimajor axis = 1.8229 AU, inclination = 0.2146°, longitude of ascending node = 291.168°, argument of perihelion = 276.4702°, and mean anomaly = 210.969°. 4 of the 6 elements are consistent with JPL's, but the argument of perihelion and mean anomaly were calculated to be significantly greater than JPL's predicted values. This suggests that gravitational perturbations from other Solar System objects may have altered the orbital elements over time.

SPA101: The Impact of Thermochromic Pigment on Roof Temperature

Regulating the absorption of heat in a roofing system may be a means to reduce heating and cooling costs in residential and commercial buildings. This exploration of the effect of color on roof temperature seeks to establish baseline values for roofs that are silver,black and white. Once baselines of are established, a coating made with thermochromic pigments applied to a standard steel roof will explore the benefits of a color changing roof based on roof temperature. In seeking to establish the viability of dark roofs in colder temperatures and light roofs in warmer conditions passive efficiencies may be obtained through lower HVAC costs. These efficiencies will be measured through evaluating heating rates of thermochromic treated roofs and quantifying costs savings due to reflected or absorbed sunlight.

SPA102: The Effect of Wind Intensity on Flute Sound Quality

Some musicians in concert bands typically decide to do marching band in their high school and/or college years. A marching band is a group of musicians, whether they are brass, woodwind, percussion, etc., who generally perform in an outdoor setting, incorporating some kind of marching technique with musical arts. The intent of this experiment is to find how the intensity of wind affects the sound quality of a flute's sound. The application Phyphox uses phone sensors to measure the frequency of the sound produced by the flute. Using the app, a comparison was made between the flute's frequency in a controlled environment to the flute's frequency in the presence of wind at different intensities. A fan was used to generate wind at varied intensities by adjusting the dial from 1 (the lowest intensity) to 3 (the greatest intensity). While the investigation and data collection is still in progress, the prediction is that the flute's sound quality will be better/more clear at a lower wind intensity versus a higher wind intensity.

SPA103: The Joys of Hydroplaning

Please visit student's exhibit for abstract

SPA104: Technicolor Shadows of Light

Visible light usually looks colorless to our eyes but is composed of a broad range of colorful light divided into bands by their wavelength, energy, and the color each produces when it hits our retina. Slight changes in the signals from the three types of cones produce the millions of colors our eyes can detect. If three microlights are shined onto a white wall at 145 degrees, then the shadow color will be purple, and the number of shadows will be the greatest. Three microlights were shined on a wall at 180, 145, & 90 degrees with a pencil in front to create a shadow, separately, together, and trichromatically to see the difference between the number of shadows and colors seen. We can compare this to the retina and the cone cells in our eyes. Comparing this to the trichromatic test, if our cone cells recognize all six colors through frequency and wavelength, we technically can see six shadows of these same colors. Though it may not be presently visible with just the naked eye, we can pick apart the colors. We can see in technicolor.

SPA105: Computational Modeling of Magnetic Moments

The Ising Model is a Canon Ensemble represented by a lattice of particles in either a spin-up (1) or spin-down (-1) state. These spins are in the same direction as the particles' magnetic moments. With each iteration of the Metropolis Algorithm, a single randomly-chosen spin is probabilistically flipped, where the probability of the flip occurring is calculated with the Boltzmann Distribution. The equation for the Boltzmann Distribution includes the difference in energy between the next and current lattice. The energy is calculated using a Hamiltonian that involves summing the products of all adjacent spins. Using the Ising Model, I answer the question of how temperature affects magnetism. First, I show that through the iteration of the model, the spins either converge to a homogenous spin state or become random, depending on temperature. In addition, the simulation reveals how ferromagnets undergo a phase change into paramagnets at about 2.269 dimensionless temperature units. Using a qualitative assessment, I also show that antiferromagnetic become less ordered at higher temperatures. Based on these results, it is clear that as temperature increases, the entropy of the system also increases, and the magnetic properties become less prominent, and the inverse applies.

SPA106: The Effects of Corrosion on the Force Laws of Springs

The purpose of this experiment is to determine how the force law of a spring changes as that spring is subjected to corrosion. To determine the force law of a spring, a spring was hung from a wooden stand. Various known masses of sand in a bucket were hung from the bottom of the spring, and the resulting changes in length of the spring were measured. The tension in the spring is equal to the weight of the sand and bucket, and this tension in the spring was plotted as a function of the stretch in the spring. Various springs of known masses were placed in a corrosive environment with hydrogen peroxide. After the spring visibly corroded, it was removed from the corrosive environment, dried, and its mass was measured again. The force law of the spring was then measured using the aforementioned method. This process was repeated multiple times for each spring in order to have varying amounts of corrosion. The mass change gave a quantitative way to measure the amount of corrosion. This allowed for the force law of the spring to be plotted as a function of the amount of corrosion. Since experimentation is still continuing, the data and conclusions will be presented on the day of the fair.

SPA107: Can gunshot residue lead to wrongful convictions?

There are thousands of cases where Gunshot Residue has led to wrongful convictions. One in particular being the case of G.S.R vs Baltimore State Attorney office. This case covers the exclusion of certain GSR testing methods from specific courts and the wrongful convictions that lead from it. Lead, barium, and antimony tests have been dismissed as evidence in a Baltimore Circuit Court judges courtroom. Due to the inconsistency of GSR testing, the residue being extremely transferable, and inaccuracy of time variables for testing I attempted to successfully detect if courts can dismiss all GSR tests based on the notion it's unreliable.

SPA108: Shoe Type Influence on Vertical Jump

This experiment is being conducted to determine whether or not different shoe technologies have an impact on an athlete's vertical leaping ability. Various shoe technologies will be measured through two different tests. The first test requires the shoe to be bent to a 45 degree angle. Proceeding this, the shoe will be release and a slow motion camera will record the time it takes (in seconds) to snap back to its original position. The second test requires the shoe to be bent to a 45 degree angle. Following this, a spring scale attached to the shoe and will measure the force the shoe exerts (in Newtons) as it snaps back to its original position.

SPA109: The Physics of Dance looking at the science behind dance moves, the differences in torque, and how Newton's Laws apply to it.

Many focus on a dancer's performance as a whole, they realize the difficulty of performing the movements being made by the dancer, or what moves they are doing to illustrate the visual image created by the choreographer; but some people like to study each movement made by a dancer, analyzing how it applies to physics and Newton's Laws. Physics is the branch of science that looks at the properties of matter and energy, which plays with motion within the art of dance. A dancer's technique can be restated by physics vocabulary. While Newton's Laws form the foundation of any physical analysis of dance. The science of dance explores the human body's reaction to movement as it changes in time and space. It also focuses on the capability of each dancer through the studies of the anatomy of the body and movement patterns. The basic principles of physics to the art of dance will be an invaluable resource for dancers and dance instructors, which will open a higher amount of appreciation for anyone who loves the art. As it will also appeal to physicists who seek to include the arts in their scientific pursuits.

SPA110: Kick Me With Your Best Shot. A dive into how to kick a football

Please visit student's exhibit for abstract

SPA111: Real Light vs Fake Light

Please visit student's exhibit for abstract

SPA112: Techniques of Electricity Generation through Everyday Actions

Many of the simple actions that are done by humans are only done to serve their intended purpose (i.e. pulling a drawer handle opens the drawer), but they aren't really harnessed or used for anything else. The objective of this project is to test how some of these repetitive everyday actions (opening a drawer, turning a doorknob, and opening a door) can be utilized to generate electricity. The goal is to experimentally research how much electricity can be generated. Additionally, various options that will be used to store the generated electricity (i.e. a battery versus a supercapacitor) will be experimented with. Specifically, it will be to see whether a sufficient amount of energy can be generated and stored to power a small household device, like a temperature or humidity sensor. In order to test this, a small wooden model will be constructed to resemble a drawer, doorknob, and door for the three actions. A motor and gear system will be used in the models to generate electricity. A multimeter will be used to measure the current and voltage generated. Different circuit designs that would enable a rechargeable battery and a supercapacitor would be tested to see if the generated voltage can charge these storage devices. Preliminary testing has already been conducted and shows that a small voltage can be generated by rotating a motor found in an RC car. The final data sets and conclusions will be presented on the day of the fair.

SPA113: Glugging Patterns of Flexible vs Rigid Containers

Most people have experienced the characteristic glug-glug sound of inverted bottles emptying their volumes. Glugging happens when water leaving a container creates a low-pressure headspace. This low pressure sucks an air bubble in through the mouth of the bottle, equalizing the pressure and causing a glug. The hypothesis of this project is that glugging behavior depends on the flexibility of the container, since the walls of a flexible container allow its volume to change to account for interior pressure changes. An airtight rigid-walled container was built and equipped with a digital pressure sensor to measure the internal air pressure. The top of the container could be replaced with a variety of elastic membranes of various diameters, thus allowing the flexibility of the container to be varied precisely. The container was filled with water, the exit hole at the bottom was opened, and the air pressure was recorded as the water emptied out. The pressure signal showed regular oscillations synchronous with each glug. Remarkably, containers with larger membranes (i.e. more flexible) drained faster than rigid containers, and glugged at up to 2-times lower frequency than rigid containers. Flexible containers also had up to 3-times larger volume of water discharged per glug. This suggests that flexing and unflexing of the membrane permits more water to drain, and more air to enter with each glug. Accordingly flexible containers empty faster because larger membranes can displace more volume.

SPA114: Running For Charge: Electricity Collected From Motion!

Energy is being lost during the occurrences of everyday activities. One example is the mechanical energy we exert while running. Finding a way to repurpose this lost energy can be beneficial. We can gather energy using two types of electrical generators, one that collects energy from each step (piezo-electric generator), and one for each leg swing (magnetic flux shaker). We can test the efficiency by assessing how much voltage is generated over a fixed period. We can also vary the position of the generators, to find the optimal position. We hypothesized that the piezo-electric generator will prevail and that the middle position for both generators would be optimal. Using a capacitor for energy storage, we were able to create a measurement circuit. A multimeter was used to measure voltage generated. Both generators were secured to one leg. Data was recorded for 15 trials (5 per position). Criteria for efficiency were average voltage generated, consistency, durability, and cost. The Shaker was found to have the best average voltage generated range (5.79 - 7.54 v) but was not as consistent as the Piezo (Shaker STD: 0.407 %u2013 0.726; Piezo: 0.048 %u2013 0.124). The Shaker was also more durable but cost more than the piezo. It was concluded that the Piezo is more efficient and that the middle position was best for the Shaker while the low position was best for the Piezo, and therefore the hypotheses were not fully supported. Further research can be done to explore optimizing the design of the piezo-electric generator.

SPA115: Application of Luminosity Modulus in Exoplanet Transits

Please visit student's exhibit for abstract

SPA116: Tracking Sunspot Cycles

Sunspots are disturbances in the sun's photosphere that help us track solar cycles. If we are able to track solar cycles, then we are able to help keep astronauts safe, and protect radio communication on Earth. In my research, I will be looking to see if there are any similarities between past solar cycles that could help us predict, and keep track of solar cycles today. I will also be testing to see if there is an easier way to view sunspots using a pinhole projector. The results of my experiment were that the onset time of a sunspot cycle is shorter than the decay time, the cycles with a higher solar maximum had a shorter onset time, and the pinhole projector worked to track sunspots depending on the weather.

SPA117: Sound Transmission Fluctuations Through Ferrofluid and Generated Magnetic Fields

Studies of photons' reaction to magnetic fields is a relatively new study, and ferrofluid engineering and physics is also a growing field. This experiment determines the influence of ferrofluid on sound waves in a magnetic field. A solenoid was created and positioned so an iPhone could fit under the copper wires to produce various sound frequencies, a glass dish was positioned on top of the wires to hold ferrofluid, and a microphone was suspended right above the dish to collect sound pressure. The same frequencies were run in the magnetic field with and without the presence of ferrofluid. It was seen that the graphs with the presence of ferrofluid registered an average of less lower sound pressures. In the resonance frequency of glass the dampening effects of the ferrofluid in coordination with direction of the magnetic field caused the wave frequencies to grow, and even caused the waves graphed to be inverted.

SPA118: Accuracy of ammo

Please visit student's exhibit for abstract