Pittsburgh Regional SCIENCE & ENGINEERING Fair
Powered by CARNEGIE SCIENCE CENTER

85th Pittsburgh Regional Science & Engineering Fair

Senior Division

Student Project Abstracts

April 3, 2024

Notes to Judges

Students prepare Abstracts 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)

Table of Contents

Behavioral and Social Science (SBS)

SBS100: The Aging Brain and Peer Pressure

This project tests the way the brain responds to peer pressure at different ages. The idea behind the study is to determine if puberty has an effect on how you make decisions when in the presence of peers versus in an independent setting. Studies and research show that the prefrontal cortex of the brain is under developed prior to puberty in most humans. The experiment consisted of 5 students in preschool, elementary, and high school. Each of the 5 students were exposed to 5 different tests where they were asked a question independently then had to answer the same question a few weeks later with their peers. Results from the study showed that preschool, elementary, and even (some) middle schoolers were more likely to sway their answers in the two settings. Further research is being conducted and gathered to determine if this is due to parts of the brain being underdeveloped and the students being more likely to stick to their ways after puberty versus when they are younger and more easily influenced by their environment and surroundings.

SBS101: Chicks vs. Predators

This project will test whether chicks are born aware of being scared of different types of predators or if they gradually gain their fear and anxiety as they are exposed to new surroundings. It is predicted that if Chicks are repeatedly exposed to a variety of predators as they develop from 2 weeks to 6 weeks old, then over time their heart rate will gradually increase when exposed to a predator because they will become more aware of their surroundings as they age. During this study the chicks heart rates were monitored over a 6 week period using a heartbeat counting formula. The data collected concluded that the predators of a weasel and fox increased the chicks heart rate over time as the chicks aged. The hawk results showed that the chicks heart rates either stayed the same or barely increased, meaning the chicks were unaffected by the hawk as they aged. The data collected during this study shows that chicks are not born with fear of predators but that their anxiety increases as they age and become more aware of their surroundings.

SBS102: Selecting Words to Teach Children During Storytime to Maximize Learning Opportunities

Read alouds have many benefits for children including language development. Books contain rich language including vocabulary words. Selecting the best words to teach during read aloud can maximize learning opportunities. Words are broken into three categories: tier one, tier two, and tier three. The best words to teach young children are tier two words; which are sophisticated words that children are less likely to encounter in everyday conversation and can be used in a variety of contexts, including storybooks. These words help children understand the text and expand their vocabulary. This investigation will determine if a vocabulary selection training exercise improves a storybook readers ability to select tier two words to teach during read aloud. If readers complete the exercise, then it will improve their ability to select vocabulary words to teach in children's books. The benefit of this study is to maximize vocabulary learning opportunities for children during storytime. This experiment will take place at Indiana Senior High School. Subjects for this study were selected because they work with children first-hand, through babysitting or participate in a Child Development course. These subjects completed a pre- and post-test, selecting words to teach from storybook pages before and after completing a training exercise. Experimentation is still in progress and results will be available at the time of presentation.

SBS103: Is Audio or Visual Information Better Retained by Students?

This project aims to determine whether audio, visual, or a combination of both helps students learn material better. Neil Fleming produced the VARK model in 1987, which represented the four different methods of teaching, which are: auditorily, visually, reading, and kinesthetically. In the years since, studies have shown that learning styles are a myth. The American Psychological Association conducted a study which found that participants' results on a short survey didn't correspond with their preferred learning style. For the current project, consent forms were distributed to grade 9-12 students. Students watched a slideshow presentation of common objects, and then were asked to recall as many as they could. There were three different slideshows, one visual, one audio, and one with both combined. The visual slideshow had 20 slides with pictures of 20 common objects. Each picture was presented for three seconds before moving on to the next picture. The audio slideshow included the same objects presented in a voiceover. The combined slideshow included the same objects, but they were presented in both picture and voiceover format. The three slideshow presentations were presented one week apart from each other and in a counterbalanced manner. It was hypothesized that students would perform better on the visual slideshow. This study will add to the literature regarding whether learning styles exist or are a myth.

SBS104: What Makes up American Identity? - A Teens' Perspective -

Many 2nd generation American citizens, coming from an immigrant family, struggle with their identity, unable to assimilate into the society's definition of American. In order to identify possible solutions, my research tests whether watching a speech on the struggles of 2nd generation Americans changes the view on the importance of traits that make up American Identity. To do this, first, I had participants rate the importance of 16 traits of American Identity on a 1 to 6 scale (not important at all to extremely important). A week later, I had them watch the speech and rate the importance of the same 16 traits again. As a result, the importance of the traits showed significant decrease after watching the video. In particular, American accent and appearance decreased the most, while American pride had a high importance both before and after, thus having a non-significant change. In addition, social connections with other Americans were the only trait that over half of the participants agreed as important even after watching the video. These results support my hypothesis that if high schoolers learn about the identity crisis of 2nd generation people, then the traits that make up American Identity will change significantly.

SBS105: How Taking Breaks Affects Student Productivity

Today, people all over the world are becoming more stressed, especially about things such as work. Most would think that getting it all over with quickly would be more enjoyable and efficient, however I always did better with taking breaks while doing my work. So, to see which strategy is truly better, I decided to test whether finishing something in one go or taking breaks in the middle of the task was better. To do so, I found 5 volunteers and gave them two algebra tests, one with a break and one without a break. Then I grade them and compare the two tests to see which one they did better at. My results are still being gathered, but I believe in my hypothesis that breaks are better for you and your breaks.

SBS106: Are perceptual decisions influenced by working memory?

Visual perception results from the brain interpreting the light falling on the eyes. But does our perception only depend on what we see, or is it also influenced by what we remember? The purpose of this project is to use psychophysical methods to investigate this question. I tested 29 subjects using a custom-designed web application. Subjects remembered two sample square images, composed of different fractions of red/green pixels. The samples were removed, and the subjects were presented with a third square (probe) whose red/green composition was in-between the samples. The subject decided which remembered sample was closer in color to the probe. This process was repeated for 250-300 trials at varying color compositions. The subjects' decisions were recorded. Subjects were tested in three conditions: difference in the sample red/green composition (S) of 20, 30 and 40%. Each S was tested with multiple probe values. The decision accuracy in the three conditions were fit with logistic regression models. My hypothesis was that perceptual decisions about a given probe would be influenced by the samples stored in memory. Specifically, I predicted that decisions about the same probe would be worse at decreasing S. To test this hypothesis quantitatively, I compared the logistic model fits for the three S. The slope of the logistic fits (measure of subject sensitivity to probe composition) differed across the three S suggesting that perceptual decisions are influenced by memory. I am currently analyzing the statistical significance of the observed effects.

SBS107: How Your Leaves Affect Your Yard

Living in western Pennsylvania where deciduous trees shed their leaves each year, it was observed that some individuals rake and remove fallen leaves, while others do not. The purpose of this experiment is to evaluate how the presence or absence of these fallen leaves may correlate to soil health. It is possible that the presence of the leaves may increase the biodiversity of organisms present in the soil, with the understanding that certain insects may contribute positively to soil health while others are not. For this experiment, macro-invertebrates, including worms and grubs, were dug up and counted. It is hypothesized that areas with leaves present would be healthier than areas with little to no leaves. Experimentation is still in progress with results to be available at the time of presentation.

SBS108: ADHD and your Brain

Please visit student's exhibit for abstract

SBS109: How does social media affect friendship?

Please visit student's exhibit for abstract

SBS110: Color Theory

My project is on color theory, seeing if different grades/genders have different opinions on what colors correlate with certain nouns. For this project, I have 2 hypotheses. One is: in each grade level, most students will have similar color choices, but across different grade levels, there will be many different colors. The other is: Teachers will have similar color choices to the students in the grade level they teach. To collect my data, I first obtained permission from high school and middle school science teachers in my district to hand out packets with the consent forms and survey to their students. I also handed out surveys to teachers. I will then collect their surveys, put the answers in google sheets, and create charts to compare the results. This project can not only benefit students, it can also benefit teachers. If most people think of science as, let's say, green, then, for teachers, printing worksheets on green paper or using a green background for their google classroom might help the students remember that that thing is for science. Also, if a teacher teaches multiple subjects, like at the elementary level, color coding papers might help them keep the younger kids organized. Likewise, using colored folders and notebooks can help everyone stay organized and know which class is with what folder without even opening the folder. 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.

SBS111: How are glasses portrayed on television shows popular with adolescents and young adults?

This experiment investigates how glasses are portrayed on television shows that are popular with adolescents and young adults. Oftentimes wearing glasses are associated with negative stereotypes. Portrayals of different types of people on television shows can affect viewers' real-life perceptions. First a script database will be searched for the last 5 years with key words of glasses and words associated with bullying (e.g. nerd, dork). The searches returned a lot of results, given the number of false positives (i.e. results talking about drinking glasses) we narrowed our search by using both glasses and contacts along with words associated with bullying. Filtering by shows that are popular with young adults and adolescents we will be able to obtain a final sample of the scripts. For each script, we will review, watch and code different aspects of each show (reality, comedy, drama), demographics of the characters (age, gender, race) and themes of each scene (e.g. bullying, discussion of characters dating). Then calculate frequencies and percentages for each coding category and use qualitative analysis to identify themes.

SBS112: How a Description Affects the Ability to Identify Individuals in a Photo Lineup

Often in the setting of an active crime, witnesses are hesitant to write descriptions of suspects. In my experiment, i wanted to test how effective a description really is in a situation like this. To do that, i used artificial intelligence to create the generic face of a woman. To 6 people, group A, i showed the photo for 30 seconds. To group b, i showed the same picture however they were the write a detailed description of the woman in the photograph. After 5 days, the 2 groups were called back to identify the woman they saw, and group b was given their descriptions. All volunteers were shown the original picture in a photo lineup of woman similar in looks. 6/6 members of group b were able to identify the woman, however 3/6 members of group a were able to identify the woman. Confirming my hypothesis that the descriptors help in identifying suspects in a photo lineup.

SBS113: Use of violet light cue to influence food-seeking behavior in Pogonomyrmex occidentalis

It is known that ant colonies consistently obtain and revisit food sources through worker ants' use of pheromones such that efficient pathways from a given nest entrance and food source can be created with ease. However, ants' sense of sight, while limited, must be utilized in obstacle avoidance, when such pathways are disrupted. Many prior studies cite that while harvester ants retain compound eyes, their sight remains blurry and unreliable on its own. This procedure introduces a novel component of visual discrimination - a consistent color cue that accompanies each food reward - to facilitate red harvester ants' visual navigation along rugged terrain as well as to evaluate their capacity for recognizing and applying useful patterns pertaining to food-seeking. Success in forming stable associations between violet light and a food reward among red harvester ants has implications for understanding factors in human learning and memory association. Ants' ability to benefit from a hyper-colorized world has direct links to what is known of color-grapheme synesthesia in humans, a condition in which symbols including letters and numbers are each ascribed a particular shade that can be seen vividly in the mind's eye. Color-grapheme synesthetes consistently outperform untrained non-synesthetes when memorizing chains of numbers and similar forms of data when colors are made to match those naturally seen in the minds of synesthetes. Results of this experiment can also be applied in the context of enhancing vision of robotics.

SBS114: Should We Help Them?

It is commonly thought that people only perform acts of service when others are around to witness. This thought sparked my testing of Bystander Apathy. The Bystander Apathy Experiment was completed with the intention of discovering whether or not individuals are more or less likely to help someone who is visibly struggling when there are a significant amount of people around, versus few. Student volunteers carried a large cumbersome box down school hallways when they were both busy, and not crowded, to test reactions and likeliness of assistance. It was concluded that individuals are more inclined to offer assistance when in an area filled with other individuals. This is believed to be because, as aforementioned, people tend to only offer assistance when praise is associated with it. Therefore, future research includes determining what other factors play into individuals likeliness to help: age, gender, grade?

SBS115: The Effect of Cultural Diversity on Religious Perception

A person's perception of different religions can be affected by the diversity of the area they live. I tested this by creating a survey that asked roughly where the participant lives, which holidays from 4 different religions they knew of and celebrate, if they agreed with religious statements on a scale of 1-10, and how likely they would be to see a certain religious clothing item on a daily basis. With the data collected from each section I compared it to the religious diversity census from the areas I got responses from. Most of the responses were from people with a Jewish faith so that affected my conclusion for the holiday section. My hypothesis for this section was neither proved nor disproved. Most of the regions studied followed the pattern in which holidays known matched up with the religious diversity of the region, excluding Judaism, but the only region that didn't follow this pattern was Israel.

SBS116: The Artificial Awareness of Students vs Teachers

Artificial Intelligence has become a part of our lives today. It can be used for many different things in many different ways. It has even been incorporated into schools. Students have been using AI to do their work for them. This has become an issue because students have AI so accessible to them. It is primarily used in writing. I am testing the difference between how well teachers vs students can detect AI in writing. I had an 11th-grade student write a short answer to a question. I had an AI on ChatGPT answer the same question and ask them to write like an 11th-grade student. I am having the four students write the answers: two girls and two boys, one of each in AP Language and the other in the regular English class. The questions asked of these students will vary. The questions given to the students were randomized. I created a form that the teacher and students take. Their task was to select the answer that the actual 11th-grade student wrote. I hypothesize that the teachers will be better at determining between the two because they are accustomed to how students write and how much knowledge they have in various areas. The experiment is still in progress and the data will be compared when all of it is collected. I will use this data to determine whether teachers and students can differentiate between AI and student writing.

SBS117: The Frustrating Factors of Teamwork

Many people find working in teams to be frustrating. The purpose of this project is to find out what specific factor is causing the most frustration, and how different demographics of people respond. This information can be used to optimize the efficiency of teamwork, and help to better understand how frustration affects individuals and the team overall. All subjects were first asked to complete a survey that measured their current frustration. Then subjects were put into teams of four and competed to put as many pieces of a puzzle together as they could under a time restraint. Each member of the team could only place one puzzle piece at a time, while also not being able to communicate with or help the other members of the team. The team to have the most pieces complete won the game. Subjects then completed a second survey that asked current frustration, and what factor they held most responsible for their frustration: time restraints, teammate pressure, pressure to win, lack of communication, or an individual member of the team. The results and conclusions will be available on fair day.

SBS118: Subconscious Marketing

Advertisements and marketing seem to be everywhere in modern life, predominating the minds of both consumers and business owners across the country. With this, many have sought new ways to promote their product with the newest trend being in what is called minimalism. However when designing a logo, one of the key factors to consider is the immediate (subconscious) attractiveness of the logo which grabs the attention of a consumer and draws them into whatever the company may be selling. This raises the question, are modernist logos more unconsciously attractive than traditional ones? To test this, participants will be shown two logos simultaneously for half of a second with one being traditional and the other minimalist. Afterwards, they will be asked which one of the logos their eyes gravitated to first to which they would then write it down. After the process is repeated several times, then the resulting data will be analyzed to see which of the two images was more appealing and determine whether or not the results are significant.

SBS119: The Effect of Conversation with an AI Model on a Person's Mental Health

Please visit student's exhibit for abstract

SBS120: Social Media's Influence on People's Perceptions of Sharks

A substantial amount of research conducted on people's perceptions of sharks has focused on the development of the perceptions; such that through Jaws and Shark Week. In the body of literature however, there is a gap in knowledge of the most effective means so as to rewrite negative perceptions to increase conservation efforts of sharks. This study included the distribution of a survey to U.S. residents between the ages of 15-30, collecting data on the impact of two positive and two negative Instagram posts of sharks on people's perceptions. The findings of this research suggest that following a positive representation of a shark in the media, negative perceptions still result. Overall, social media was found to be ineffective in rewriting people's negative perceptions of sharks. Thus, other methods applicable to today's society should be reviewed so as to alter the overall stigma towards sharks, increase conservation efforts, and raise awareness of sharks.

SBS121: Voting Theory in the Pennsylvania 2022 Senate Election

The single-ballot plurality voting system has remained the standard in the United States dating back to the 18th century. However, in recent years, the nature of plurality rule has recently been contested by alternatives. Non-plurality methods of voting - such as ranked-choice, negative, and approval voting - often yield varied results. While scholars have considered the impact non-plurality voting systems could have on U.S. election outcomes, a gap in knowledge remains pertaining to how these systems will affect partisan vote distribution in multi-party (non-primary) elections. This study utilizes a survey approach modeled after the ballots used in Pennsylvania's 2022 Senate election in order to determine how voter support for candidates may change as a result of non-plurality voting methods being used. This study is still in the process of data collection, so final results will be shared on the day of the competition.

SBS122: Can Fiddler Crabs Learn?

Please visit student's exhibit for abstract

SBS123: Should We Be Worrying: The Relationship Between Music and Productivity of Teens

To obtain higher productivity rates, an individual's time taken and accuracy must be looked at. An experiment was held that looked over the impact made by listening to music and the productivity of teenagers. The three different genres of music looked at over this experiment were pop, classical, and rock. Results showed that if classical music was listened to while taking a reading comprehension test, the amount of questions correctly answered with a relation to time taken will produce more success compared to both no music and other styles of music listened to. Traits that do not affect an individual's ability to answer questions will not be affected. The genre of music and rate of productivity contributed to the result due to the factor of focus. The better-suited genre for the comprehension tests directly engages with the individual's focus and intent, causing an effect in achieving both quantity and accuracy.

SBS124: The Effects of Social Media VS Reality on FOMO and Teenagers' Mental Health

Please visit student's exhibit for abstract

SBS125: Can Financial Literacy Contribute to Addressing Climate Change?

This research explores the intricate relationship between financial decisions and their impact on climate change solutions within the context of green finance. It emphasizes the role of financial literacy in shaping sustainable choices and investigates how individual financial behaviors contribute to environmental sustainability. Recognizing financial literacy as a powerful tool, the study aims to bridge gaps between financial and climate change literacy, revealing insights into fostering environmentally responsible behaviors. Acknowledging that direct climate change benefits may not be immediately evident, the research underscores financial literacy's pivotal role as a tangible entry point. Promoting financial literacy aims to draw attention to the interconnectedness of individual financial decisions as potential solutions to climate change. This dual impact fosters positive change by benefiting individuals directly and contributing to collective environmental sustainability efforts. Additionally, the research analyzes the correlation between consumer spending, investment decisions, and saving habits in relation to environmentally conscious choices. It aims to uncover mechanisms through which financial decisions can affect climate change issues. The study also acknowledges the potential impact of educational interventions on influencing sustainable financial behaviors, with a focus on students. This research has two primary goals: firstly, to uncover insights into the under-explored link between financial choices and their impact on climate change solutions, and secondly, to offer actionable recommendations for promoting sustainable financial practices, particularly among younger demographics, actively contributing to global efforts to combat climate change.

SBS126: Econometric Modeling and Applications of Conflux Blockchain in the Grameen Bank: Proposed Framework for Increased Social Welfare in Poverty Alleviation

This proposal merges the traditional microfinance model with the Conflux blockchain to create a groundbreaking solution in credit disbursion. My study intricately evaluates three specific variables that depict how the Conflux blockchain positively impacts social welfare. My analysis encompasses econometric testing of monetary benefits, evaluates transaction speed enhancements, and explores the novel effects of information symmetry. First, by employing econometric methodologies, my study quantifies the economic advantages created by the Conflux blockchain within the microfinance ecosystem. Findings delineate a tangible increase in societal monetary welfare, proving a positive economic influence on all parties operating within this novel model. Second, my study underscores the accelerated transaction speeds created by the Conflux blockchain and points to greater efficiency in microfinance systems. Faster transaction speeds extend not only convenience but also contribute to the aggregate accessibility to microfinance operations. Last, the integration of smart contracts is investigated as a measure to nullify information asymmetry. The Conflux blockchain provides universal transparency to all transactional parties, which mitigates imbalances in loan history and ensures higher loan repayment rates as a result of heightened trust. This research presents a novel understanding of microfinance systems, showcasing the transformative potential of blockchain technology. The findings contribute not only to the understanding of these systems in theory but also provide empirical insights for stakeholders, policymakers, and practitioners who may be able to use this integrated technology in other societal solutions.

SBS127: Yoga on Our Minds: A Systematic Review of the effectiveness of yoga on patients with Alzheimer's Disease

Nowadays, a large number of people suffer from Alzheimer's disease. The illness cannot be cured by current medications, nor will all medications be effective for all patients. This is the reason why there is a need to better understand Alzheimer's and other forms of dementia and to identify novel therapeutic strategies. Despite this, there is no viable treatment that can cure Alzheimer's. However, some studies suggest that a mind-body therapy like yoga can have positive effects on Alzheimer's patients and may even cure acute Alzheimer's diseases. Yoga helps improve general wellness by relieving stress,supporting good health habits, and improving mental/emotional health, sleep, and balance. This systematic review seeks to examine the actual effects of yoga on Alzheimer's disease by analyzing randomized trials conducted on patients with acute Alzheimer's disease. The research papers are selected from the past five years of scientific research databases, such as PubMed and Google Scholar. They are accepted if the inclusion criterion is met. The data from all the trials will be analyzed in terms of specific symptoms being affected by yoga intervention, to provide more insight into the potential benefits of this practice. If the data and the result from all the research come to a positive result then the result will help the patients with Alzheimer's disease to get an effective treatment that not only reduces their signs and symptoms but also their overall wellbeing.

SBS128: Exploring the Behavioral Impacts of Social Media

The transition to a digital society has had tremendous impacts on the way we communicate and process information. Especially recently, there has been a lot discourse on the negative effects of social media, not just mental health wise, but on a users attention span. My project will aim to verify whether the constant exposure to short videos designed to catch your eye can actually detriment your ability to focus on longer videos or readings. For my experiment I will ask voluntary participants of the adolescent range to take two baseline quizzes, one on exoplanets and one of jellyfish. I will ask the participants to next watch a 10 minute long exoplanet video and retake the exoplanet baseline quiz. Then I will ask the participants to watch twenty 30 second videos on Jellyfish (designated to replicate reels or TikToks) and retake the jellyfish quiz. From there I will compare the baseline to the post experiment quiz data of both topics to determine whether social media has affected users' ability to process information. Additionally, from a personal point of view, I wish to evaluate what the change or lack of change in attention spans means for our society, especially since this topic has been promoted with such a negative stigma thus far.

SBS300: Gender and Friendship

Please visit student's exhibit for abstract

Biology (SBI)

SBI100: RhoA Signaling is a Convergence Point for Nogo Receptor and Brain-Derived Neurotrophic Factor for Synapse Stabilization

While the respective synapse growth and inhibition signaling of brain-derived neurotrophic factor (BDNF) and the Nogo receptor (NgR) are well described, how these pathways function together to regulate the assembly of excitatory synapses is unclear. Employing live dual-sensor imaging of dissociated hippocampal neurons undergoing synapse development, we map in individual neurons BDNF calcium events in concert with the GTPase activity of RhoA, an intracellular mediator of NgR's inhibition of synapse formation. We find endogenous RhoA and calcium signals negatively correlate with one another in pyramidal neuron dendrites but not spines or axons, suggesting these pathways may oppose one another specifically in this domain. Consistent with this hypothesis, pharmacological, genetic, and optogenetic activation of RhoA or calcium signaling inhibits the opposing pathway in dendrites. Our imaging and electrophysiological studies reveal BDNF promotes synaptogenesis by Protein Kinase A (PKA) activation of T-type calcium channel currents, a function mediated in part by inhibition of RhoA signaling. Rho Kinase (ROCK), a key mediator of RhoA signaling, phosphorylates calcium T-channel CaV3.1, inhibiting its ability to initiate calcium-dependent synapse development. Expression of a CaV3.1 ROCK phosphomutant (CaV3.1-M1,M2) increases synapse number and reverses Nogo-dependent spine loss, suggesting T-channel phosphorylation at M1,M2 sites are required for Nogo-NgR1-mediated inhibition of spine assembly. Therapies targeting NgR-T-channel signaling may be of potential value in the treatment of cognitive disorders. Time-lapse kymographic imaging of early steps in synaptogenesis pinpoint a key step that may be inhibited by NgR-RhoA signaling: axon-filopodial contact stabilization. Subsequently, our trials of Contextual Fear Conditioning (CFC) on adult mice in emerging software (ezTrack) provide insight into future in vivo analysis studying the imbalance between NgR and BDNF activity in dysfunctional learning circuits such as the hippocampus. This will lay the foundational knowledge for future research. In total, this work identifies the GTPase RhoA as a point of convergence among competing synaptic signaling pathways, one which may ensure proper orchestration of the early stages of synapse assembly.

SBI101: Diet and Growth of Mini Rex Rabbits

The purpose of this project was to determine if rabbits gain more weight based on an all pellet or all vegetable diet. The results gathered from this experiment will allow rabbit owners, rabbit breeders, and those working with rabbits to understand the positives and negatives of their rabbit's diets. This project will allow rabbits to gain weight efficiently, when needing to reach certain weight goals for the fair and showing purposes. During this study, rabbits were put in 2 groups and a fed specific type of food. One group was fed only pellet food, while the other was given only vegetables for a six-week period. I collected data by weighing the rabbits every Sunday for six weeks. The data that was collected was put into two different data tables and organized to identify which group of rabbits gained the most weight, in the healthiest and most efficient manner. After experimentation, I concluded that the pellet fed group of rabbits was more successful with weight gain as compared to the all-vegetable rabbit group. Both groups of rabbits still sustained a healthy weight. However, the data shows the more efficient feeding technique was the pellet food.

SBI102: Probabilistic Graphical Models Identify Transcriptomic and Clinical Markers for All-Cause Mortality in Moderate to Severe COPD

Chronic obstructive pulmonary disease (COPD) is a leading cause of mortality worldwide. Identifying transcriptomic and clinical markers associated with mortality risk in COPD can enable personalized prognosis assessments and treatment. This study aimed to uncover robust mortality risk markers in moderate-severe COPD patients by integrating transcriptomic and clinical data using probabilistic graphical models. A cohort of 1,037 COPD patients classified by GOLD stages II-IV was utilized. 500 transcriptomic predictors were selected via hierarchical clustering of RNA-seq data. Clinical predictors included demographics, comorbidities, and immune cell proportions estimated by deconvolution. Survival analysis constructed overall survival time and event indicators as the outcome. A 10-fold cross-validation framework implemented mixed graphical models to learn an initial skeleton graph of variable relationships, which PC-Stable then oriented based on known relationships. Edges connected to overall survival were interpreted as mortality risk markers and input to a Cox model to derive hazard ratios. The novel transcriptomic marker PTPRK (HR 0.71) and walking distance (HR 1.21) were significantly associated with mortality. The identified markers effectively stratified patients into risk groups based on COPD severity, with the high-risk group showing significantly worse 5-year survival probability compared to low and medium-risk groups (p

SBI103: No Action Today, No More Tomorrow

Antibiotic resistance is a growing issue that medical professionals have been seeing an uptick in through recent years. There are an estimated 2.8 million cases of antibiotic resistant bacterial infections each year within the U.S. Eventually superbugs can develop which are theorized to be what's going to destroy the human race. If action is not taken today to determine how to prevent or efficiently revert antibiotic resistance, a tomorrow cannot be guaranteed. Therefore, I have decided to conduct research on antibiotic resistance to determine how easily and efficiently the resistant phenotype can be reverted after having developed resistance to the antibiotic that the bacteria is most susceptible to. Data will be collected as to how much the inhibition zone shrinks when antibiotic resistance is being mutated into the bacteria. A graph will be presented to show the decrease in susceptibility which shows development of antibiotic resistance. The antibiotic resistant phenotype of the bacteria will be reverted to ultimately succumb to a wild phenotype once again. This will be exposed to the antibiotic and data will be analyzed. Results will be available the day of competition.

SBI104: Can Music Mimic Bird Song

Budgies are social birds that use birdsong, or warbling, to communicate with each other. Like humans, budgies are vocal learners meaning that they can learn and copy sounds in their environment, which is a rare trait in nature. Humans and songbirds use the same part of their brains for vocal learning, so while humans can learn and remember music, budgies can learn and remember birdsong. My question is if music can mimic birdsong. When budgies hear birdsong, they respond by warbling. My hypothesis is that if I play different sounds to the budgie, then the budgie will warble the same amount when he hears classical music than when he hears other budgies warbling. To test my hypothesis I set up an experiment where I played a recording of different sounds, and recorded audio of the budgie warbling. In randomized 10 minute sessions, I tested the budgies' response to random notes with fast steady rhythm, fast variable rhythm, slow steady rhythm, and slow variable rhythm. In addition I tested traditional western classical piano music, a group of budgies warbling (positive control), and no sound (negative control). After the audio was recorded, I reviewed them to see how long the bird warbled for each sound. The budgie did not warble for the no sound control or the slow random notes with or without a steady beat (less than 1 second of warbling average across six replicates). The budgie warbled an average of 91 and 222 seconds for the random notes with a variable and steady beat respectively. The music and positive control had similar average warbling times of 80 and 154 seconds across six replicates. These results did not support my hypothesis because the budgies warbled more to the warbling than the classical music. The budgie's reaction to the random fast notes might be because the budgie identified rapid changes in pitch to be birdsong, even though the notes presented did not have a traditional melody. However, random notes is also a type of non-traditional music called aleatory music. With this in mind, the results of my experiment show that budgies may identify fast changes in pitch as birdsong.

SBI105: Cinnamomum zeylanicum Blume vs Agrobacterium tumefaciens

Agrobacterium tumefaciens is a bacteria that causes crown galls. Crown galls are tumors that grow on certain types of plants. Cinnamon has been researched for its potential application in cancer prevention (Caserta.S.) The purpose of this study was to see if cinnamon could inhibit the growth of tumors on a Solanum tuberosum. In the first treatment group potatoes will be inoculated with Agrobacterium tumefaciens and no cinnamon. The second treatment group will be cinnamon powder mixed with the bacterium before inoculation. The final group will have cinnamon oil mixed with the bacterium. The hypothesis was that the cinnamon oil mixture will work better than the cinnamon powder mixture. This hypothesis was formed because the cinnamon bark oil is extracted from deep inside the cinnamon bark tree. The statistics showed that cinnamon is sometimes a reliable treatment, but it also can be a non reliable treatment. The cinnamon did inhibit some of the tumors but not all. The ANOVA and T-tests had a variation of values. The cinnamon oil did not do anything. However, the powder increased the amount of tumors but not the size. My hypothesis was not supported.

SBI106: How the amount Poly(methyl methacrylate) affects the durability of a PMMA scaffold

In starting this project, I made a first step towards understanding the basic mechanisms in tissue engineering, as well as the applications of certain technologies and how they are used. I decided to do a project studying the mechanisms of a tissue scaffold because of its notable incorporation into tissue engineering, a field of interest that I plan to explore even past this experiment. This all roots from the fact that I plan to pursue a career in biomedical engineering, and this project allows me to study a fundamental aspect of the scientific field. The PMMA scaffold itself is widely used in bone tissue engineering because of its high mechanical properties and ability to resist degradation. Taking this into account for my experiment, I wanted to see how altering the amounts of PMMA in the scaffold could alter such properties and therefore its acceptance into the realm of bone tissue engineering. Therefore, after creating the scaffold, I determined its ability to resist bending, and hence its durability, by placing it between two wooden blocks and putting 150 grams of mass in the center of the scaffold. The result was interesting. The scaffolds with high amounts of PMMA were able to resist bending more than the control scaffold with a PMMA amount of 0.8 grams, while those with lower PMMA amounts were much more flexible and bent much more. The extent by which the scaffolds with less PMMA bent was also significantly more drastic in comparison to the control, whereas those with a higher PMMA amount bent in closer comparison to the control. The conclusion in the end was that scaffolds with higher PMMA had a higher durability, and those with lower amounts had a significantly lower durability.

SBI107: Vitamin C Effects on the Suppression of Tumor Growth

Please visit student's exhibit for abstract

SBI108: The Role of Iron in DMG Tumor Growth

High-grade gliomas (HGGs) are the most common intrinsic brain tumors in pediatric patients. H3K27-altered diffuse midline gliomas (DMG-H3K27a), a subgroup of HGGs characterized by a mutation on histone 3 protein in lysine at position 27, are especially aggressive and have a low survival rate. Iron is an essential trace element that is involved in many important biological processes in the human body such as the synthesis of oxygen transport proteins and DNA. Emerging evidence shows that dysregulated iron metabolism promotes the growth and development of various types of tumors, including HGGs. As such, there is growing interest in targeting HGGs' dependence on iron, namely through iron chelation therapy. Iron chelators sequester and prevent tumor cells from using free iron, which leads to impaired tumor cell replication, metabolism, and growth. However, the impact of iron chelation on DMG-H3K27a tumors has not been well-studied. Therefore, the primary objectives of this project were to 1) confirm the presence of iron-related proteins using immunofluorescence (IF) and confocal microscopy, and 2) study the effect of iron chelation using 'omic' technologies on two DMG-H3K27a cell lines (DIPG04 & SF8628). In all, this project furthers our understanding of the role of iron in DMG-H3K27a tumor growth.

SBI109: Are organic or synthetic fertilizers more efficient for indoor house plants, specifically jade plants?

Fertilizers are advertised vigorously, organic and inorganic kinds; and this study evaluates ways to quantify the efficiency of each fertilizer type in their ability to increase the growth rate of indoor house plants. Two rows of five plants each were planted. They were all given common ingredients, soil, water and sunlight. One row was provided with an equal amount of organic fertilizers and another row was provided with exactly the same amount of inorganic fertilizers. Plants treated with organic and inorganic fertilizers did not show any appreciable difference in growth patterns. Future studies are being planned to increase the number of plants in the study to discern any differences.

SBI110: Caffeine's affect on sleep quality

Please visit student's exhibit for abstract

SBI111: Plant adaptation effect on DNA

Please visit student's exhibit for abstract

SBI112: Caenorhabditis elegans Drp1 Knockouts stress responses to assess cellular functions

Mitochondria are an organelle that are responsible for multiple jobs within the cell, including energy production and cell death regulation, and are essential for proper cellular function and survival. Drp1 is a cytosolic protein which facilitates fission of the mitochondria. The shape and size of the mitochondria is linked to its function and regulation, therefore Drp1 is an essential protein. Splice variants of Drp1 exist that localize to different areas within the cell and seem to differently affect fission capacity, which is why different variants of the protein may impact mitochondrial functions. The splice variants that are of interest to my project are those relating to exons 16 and 17. Patients with ovarian cancer containing high levels of Drp1 that lacks exon 16 have a significantly decreased survival rate. The absence of exon 16 decreases fission and enhances proliferation. We would like to further our understanding about what mechanisms the different Drp1 splice variants control. My project will assess different stress effects on C. elegans (as model organisms) without Drp1 and investigate how the absence of this protein affects their development. cDNA (complimentary DNA) from both groups were run in a gel to verify the knockout gene. Drp1 knockout C. elegans and control N2 C. elegans were treated with varying stressors, including heat shock in an incubator, cold tolerance in a refrigerator, and sodium azide agar plates. Survival assays were conducted after each experiment to assess the impact on each group by counting the dead vs. live worms, and progeny if applicable. Experiment is ongoing and results will be available the day of the event.

SBI113: Antimicrobial Resistance Genes in Soil Within the Community

Antibiotics have been used to improve human health for decades. However, there is now a growing concern of antibiotic resistance, which is occurring more frequently than in the past. This project focuses on one class, β-lactam antibiotics. The reason that resistance is happening in this particular class is due to bacteria producing the enzyme β-lactamase. As a result, this project aims to test the prevalence of β-lactamase genes in the environment, specifically in Indiana University of Pennsylvania and the surrounding area. Soil samples were collected in different areas of campus, which ranged from soil by sidewalks and/or structures to soil in an area with little to no foot traffic. Following that, the sample was homogenized with a lysis tube. Once this was complete, the lysate was filtered. Then, the sample was binded, washed, and eluted. The concentration was also measured during this step. Samples were then PCR amplified in order for samples to undergo gel electrophoresis. Finally, the DNA was visualized and bp was compared. The results of this experiment will be available the day of the fair due to the project still being in progress. However, it is expected that four different locations resulted in the presence of the β-lactamase gene, OXA-48. Another trial is undergoing to ensure these hits were not a false positive. These locations included sidewalks by an auditorium, dining hall, social science building, and bench close to a common area.

SBI114: The Effects of Artificial Sweeteners on B16 Melanoma and MC38 Sarcoma Tumor Cells

Title: Danger of Artificial Sweeteners combined with Tumor Cells Scholar: Camilla Zarour PI of Lab: Abby Overacre Mentors: Abby Overacre, Jess Jana, Kristin Morder Site: ICI (Immunotherapy) The association between intake of Non-Nutritional Sweeteners (NNS) and occurrence of cancers has been underlined by the World Health Organization. The reasons supporting such association remain unknown. To address this question, we have evaluated the role of NSS on tumor cell growth in vitro and in vivo. Melanoma B16 and sarcoma MC38 murine cell lines were cultured in the presence of multiple NNS or regular cell medium as control. We observed no significant effect on tumor cell growth in vitro. We next implanted MC38 tumors in mice obtained from either the Jackson laboratories (Jax) or Taconic Biosciences (Tac) and treat them with immunotherapy (anti-PD-1 antibody) with or without sucralose (Splenda) in addition to regular diet. As expected, tumor growth grew less in the presence of anti-PD-1 but these effects were decreased in Jax mice and abrogated in Tac mice. Altogether, our data in vitro and in vivo support that Splenda does not act directly on tumor cells but act on the immune system to impede the effects of immunotherapy. Interestingly, Jax and Tac mice exhibit distinct gut microbiome compositions. Therefore, we hypothesize that Splenda may act on immune cells either directly or indirectly through the gut microbiome to impede anti-tumor immunity. Along this line, there is strong evidence that gut commensals may influence response to immunotherapy in cancer patients. Our findings provide the rationale for additional studies in mice and in humans to evaluate the mechanism used by Splenda to impede antitumor-immunity immune cells and alter gut microbiome composition.

SBI115: Environmental Exposure to Arsenic

Please visit student's exhibit for abstract

SBI116: The Effects of Water Quality on Aquatic Plant Growth

My project is The Effects of Water Quality on Aquatic Plant Growth. In this experiment, I tested different water sources on elodea aquatic plants to see the effects of water quality on their growth. This research helps us understand how water quality has such a large impact on the environment. Toxic chemicals can get into aquatic plants' systems through their roots which the marine life and humans benefit from. When ingesting these toxic chemicals, can lead to very harmful sicknesses that can be terrible for you and your body. In our society, many people struggle with too little or overpopulation of aquatic plants in their water sources. Aquatic plants are a significant factor in marine life and the environment. It is important to know its benefits and the factors to grow it. This experiment will see how different water qualities can prohibit or excel aquatic plant growth.

SBI117: Modeling Catalase to Understand its Regulation

This experiment is finding regulations on the enzyme, catalase, to understand preventative measures to take when dealing with early symptoms of Takahara disease produced from the disease acatalasemia. Low catalase production in a body with acatalasemia causes hydrogen peroxide buildup which can damage proteins on cell membranes and lead to soft tissue damage, especially in the mouth. Takahara disease is seen with the effects of mouth ulcers and gangrene. Ulcers are formed from soft-tissue damage caused by oxidative stress from high concentrations of hydrogen peroxide. To counter these issues, this experiment will model catalase reaction to test different oral hygienic products. The products will be tested on potatoes, which like most living things, contain catalase. Potatoes are commonly used to demonstrate catalase reaction with hydrogen peroxide. By understanding the results found in this project, people living with acatalasemia can improve oral hygiene to restrain early Takahara disease symptoms.

SBI118: Effectiveness of Home Remedies on Spotted Lanternflies

The Spotted Lantern Fly is an invasive species that has become a threat to my community. One of the ways they are causing a threat is by killing trees in the area. The large number of bugs are causing disruption to my community. My experiment tests if home remedies like Dawn dish soap and Vinegar are effective ways to kill the bugs. The experiment tested what remedy would work the fastest. I chose home remedies as the product used because dish soap and vinegar are two household items that are usually in stock in a home. Over the course of the experiment, it was shown that the Dawn dish soap worked not only better than the vinegar, but also had consistent times.

SBI119: How the Types of Compost Effect Spider Plant's Mass

Spider plants are an indoor plant, and this study delves into the influence of various cold compost materials on spider plants. The cold compost materials used are crushed eggshells, vegetable/fruit scraps, and a mixture of both. To find which created the highest increase in mass, I observed the different treatment groups for 9 weeks. I measured the spider plant mass each week and compared the results. Eggshells alone exhibited the most substantial increase followed, rejecting my hypothesis that the mixture's mass would increase the most.

SBI120: Effect of inhaler on lactic acid threshold for people with asthma vs people without

Please visit student's exhibit for abstract

SBI121: Effect of household laundry products on Luminol test

As forensics are becoming more widely popular, criminals are realizing the need to clean up their crime scenes more. This experiment is to show how the cleaning of blood from tiles can affect possible tests done on the surface, such as the forensic luminol test. Bleach and Stain remover are chemicals that criminals may use to cover their tracks, and therefore it is important to know their effects on the brightness of the chemiluminescence. In this experiment, blood was placed on tiles and allowed to sit, before being cleaned and tested by luminol. The pictures obtained from this revealed that the stain remover had the largest effect on the chemiluminescence, which shows that it is a more effective way to clean a crime scene. This information shows that detectives and investigators alike should take caution in carefully looking for surfaces cleaned by stain remover. In the future, an experiment that explores the effect of various other cleaning products on such bloodstains could be investigated, which could show more chemical's effect on chemiluminescence.

SBI122: The Effects of Different Fertilizers on Arugula Growth

I planted arugula seeds in 12 different peat pots using potting soil. I then watered them every other day until they each plant grew to be 3 cm. I made a fertilizer with used coffee grounds and water. I ordered an organic fertilizer and mixed it with water. I separated samples into 3 groups of 4. I watered one group with coffee fertilizer, one with organic fertilizer, and I left one with only water. I will measure the average growth of each plant and determine which fertilizer worked the best for arugula.

SBI124: The Effect of Temperature on the Frequency of Supplemental Feeder Use

Approximately 10,000 bird species inhabit the Earth, with around 4,000 engaging in migratory behavior. Migratory birds undertake journeys to different locations for various reasons, with seasonal migration being the most prevalent. Seasonal migration involves birds traveling between wintering and breeding grounds, making crucial stopovers at sites rich in food resources to replenish energy. This study focuses on irruptive migration, where birds migrate based on food availability rather than hormonal changes. Migratory bird populations, encompassing diverse species, face threats such as endangerment and rapid declines. Climate change emerges as a potential culprit, altering migratory paths, relocating stopover sites, breeding, and wintering grounds, thereby disrupting the availability of essential food sources. This investigation aims to explore the relationship between weather conditions or outdoor temperatures and the frequency of birds utilizing supplemental feeders. Additionally, the study seeks to discern whether migratory birds exhibit a preference for calorically dense food options, such as black oil sunflowers, compared to less calorically dense alternatives like millet. The goal is to shed light on the impact of environmental factors on bird behavior and inform conservation efforts for these vulnerable populations. With the investigation still in progress, data and results will be available at time of presentation.

SBI125: Should we be putting this in our ears?

Should we be putting this in our ears is a project to see if there is a bacteria build up on headphones and what is the most effective way to clean them. Three different types of headphones (over ear, hard Apple Airpod earbuds, and soft earbuds) were swabbed inside and out and cultured using nutrient agar in a petri dish. For cleaning, UV light was used and wet wipes containing bleach. The data will be analyzed to see which decreased the bacteria amount the most.

SBI126: Microglial Responses to Electrode Insertion and Subsequent Low-Frequency Stimulation

Background: Implanting electrodes into the brain allows for both stimulating and recording the brain's activity. These implants can be used for both studying the electrical signals from the brain as well as controlling and treating specific conditions such as Parkinson's Disease, epilepsy, and depression. However, the electrode's effectiveness deteriorates over time due to natural immune responses in the brain, which cause scarring and inflammation at the site of the implantation. Microglia, a glial cell in the brain, influences this immune response, and therefore a better understanding of the microglia's behavior and response to electrode insertion will support treatments to help improve the longevity of implanted electrodes. I hypothesize that microglia closer to the electrode will conduct less surveillance, or analysis of surroundings, than those further from the electrode site. Procedure: My lab used a mouse model that expressed green fluorescent protein (GFP) in microglia. Michigan-style electrodes were implanted into the brains of these mice. The brains were analyzed for 1 hour and 40 minutes (20 minutes before ICMS, 1 hour ICMS, and 20 minutes after ICMS) the day of the electrode insertion (~ 1 hour after electrode insertion). Using multiple series of images generated from that data collection, I analyzed to what extent the microglial cells continued to survey their surroundings over those periods of time. Results: Data suggests a positive relationship between the activity of individual microglia and its distance from the electrode insertion site during the acute phase of the injury. Microglia greater than ~250 μm away from the electrode, on average, had 12 to 18 more μm of total process movement than those closer to the electrode. No significant difference in process extension/retraction was identified between baseline and stimulation timepoints. Conclusion: The study suggests that microglia near the electrode insertion site are less active than microglia further away in the hours following insertion, which may be a result of microglia near the insertion site interacting with the wound or nearby neurons rather than surveilling their surroundings. More data may support significant differences in behavior between stimulation and baseline timepoints.

SBI127: Mutations in Intrinsically Disordered Proteins (IDPs) Lead to Fertility Defects in C. elegans

Intrinsically disordered regions (IDRs) play critical functions in proteins without having a fixed structure. Unlike most proteins, which fold into specific conformations to carry out their functions, IDRs are flexible and dynamic, lacking a fixed structure even in the absence of molecular interactions. Despite this, IDRs have specific amino acid compositions and properties that are essential for protein function. At the same time, they have different evolutionary constraints on them because they need only retain charge and not a specific amino acid composition. In this regard, they may appear to berapidly evolving while in fact retaining function. Caenorhabditis elegans (C. elegans) is a transparent free living nematode with a short life cycle of around three days. This makes it a really powerful model for genetic assays, and the lab that I am working in uses this model to research genes involved in fertility. They have asked whether uncharacterized IDR proteins may contribute novel germline functions. This led them to pursue a RNA interference (RNAi) knockdown screen that uncovered interesting reproductive phenotypes for some of these intrinsically disordered protein (IDPs) encoding genes. RNAi against y40b1b.7 was particularly interesting because it led to sterility and has a human ortholog (CCDC86), which may be important for cell division. In wild type worms, the anterior and posterior gonads first produce sperm, which are stored in the spermatheca, and then switch to produce oocytes with diakinesis and diplotene oocytes seen on day 1 of adulthood and fertilized eggs accumulating in the uterus. In the strain with the y40b1b.7 gene knocked down, they only begin oogenesis as day 3 adults, indicating a significant delay in the production of oocytes. In the wild-type strain starts, eggs are laid, but in the mutated strain, many of the fertilized eggs hatch inside of the worm, suggesting that there is a problem with the worm's vulva due to the y40b1b.7 knockdown. Further research on the function of the y40b1b.7 gene in C. elegans could lead to a better understanding of its ortholog in humans and ultimately could reveal an important player in human reproduction.

SBI128: The Effect of Gravity on Plant Growth

The goal in this experiment was to find out if gravity effects plant growth. The hypothesis was that if gravity affects plant growth, then the plants in the clinostat and the ones labeled switch will be less healthy than the plants labeled control and 90 degrees because the roots and stems may struggle to find an upward and downward direction leading to disfigurement which can cause malnutrition and the water distribution may be off leading to certain parts of the plant being possibly drowned or being dehydrated (Plants in Space: What Can Space Conditions Teach Us About Plants on Earth?). The way the procedure was done by putting four petri dishes labeled control, switch, 90 degree, and clinostat each with nine seeds, be put in front of a window for a little over five days. The one labeled clinostat was on a clinostat, the one labeled 90 degree was put 90 degrees on its side, and the one labelled switch would be moved 90 degrees after at least five seeds germinated. The data pointed to switch being one of the healthiest with only one of the seeds not germinating and having the largest plant lengths on average with 9 cm. In the clinostat all nine of the seeds germinated but it had the lowest average length with 5 cm. The control had the lowest number of seeds germinated with seven and the second shortest length with 5.5 cm. This may have been because the phone recording could have been blocking some sunlight from the dishes in front of it. With the 90 degree, 8 seeds germinated, and it had the second longest lengths with 6.7 cm on average. Some seeds may have not sprouted just because they were bad seeds or were put too deep into the agar-agar.

SBI129: Cultivating Neuronal Resilience: Harnessing the Potential of Plant-Derived Senolytics in Neurospheres

Background and Rationale: Neurological disorders, including stroke, Alzheimer's disease, and Parkinson's disease, share a common thread: neuronal stress leading to dysfunction and eventual cell death. Consequently, interventions aimed at enhancing the resilience of neuronal cells under stress conditions could hold significant promise for preventing and treating these debilitating conditions. Quercetin, a plant-derived (onions, apples, kale, broccoli, red lettuce, etc.) polyphenolic flavonoid, has been used for its potential antioxidant properties and senolytic potential though limited mechanistic studies have tested it in neurological diseases. Hypothesis: Quercetin functions as a protective agent for neuronal cells exposed to cellular stressors. Methods: Human Neural Progenitor Cells (NPCs) have been obtained from Stem Cell Technologies. Using the supplied protocols, the NPCs were plated into 96 well plates, and NPC growth media was changed every day. After 7 days, the cells will have reached 80 percent confluence and will be used for experiments. H2O2 (50, 100, and 200æM for 2 hours) will be used to induce oxidative stress, with or without Quercetin (50æM), and cell viability will be assessed along with assays for oxidative stress and senescence using mitosox and beta-galactosidase assays respectively. Results: Initial experiments focused on the feasibility of culturing NPCs. While growing these cells was challenging in the beginning, the conditions to grow the cells have been optimized. Experiments to test NPC response to oxidative stress are ongoing. Conclusion: The study is ongoing, and initial feasibility experiments growing neural progenitor cells were successful. Full results and conclusions will be presented at the science fair.

SBI130: Toxic Cleaning Supplies

Please visit student's exhibit for abstract

SBI131: The Life and Times of Annular Gap Junction Vesicles

Gap junction channels allow cells to communicate materials with one another. Channel internalization results in loss of communication and the annular gap junction formation in the cytoplasm. To analyze the fate of annular gap junctions, computer-assisted image analysis with Imaris software was used. Annular junctions are divided, fused with organelles, and recycled to the cell surface. Further investigation will determine if annular gap junctions deliver proteins to other organelles. Background: Cells communicate with one another by passing materials through cell surface channels, called gap junction channels. These channels are important in regulating cell behavior. They are composed of proteins, connexins, that assemble into hemichannels. Hemichannels from contacting cells pair with one another to form the channels that then cluster into gap junction plaques. Plaque removal from the surface results in annular gap junction formation. Annular gap junctions are degraded by lysosomes; however, it is hypothesized that they have other fates. To accurately track annular gap junction fates, data was collected with a lattice light sheet 3-D microscope which reduced phototoxicity/quenching (a problem with conventional imaging). Methods: Human adrenal tumor cells (SW-13) transfected to express emerald-green, fluorescent connexin and M-cherryRed membrane marker were used. Light sheet lattice microscope images were collected at the Janelia Research Campus-Virginia and the data was transported to me to analyze with Imaris Software. Changes in annular gap junction size, shape, interactions, and movement were measured. Results: Four-dimensional rotation allowed us to analyze the images and determine if annular were in contact or overlapping organelles or changed plans rather than being lost from few (problems with typical live cell imaging). We selected the annular to be 0.5. An average annular gap junction size with a diameter was selected for tracking. The average annular gap junction track speed was 0.70 æm/s ñ0.34. Annular fused with membrane vehicles divided and flatted out at the cell membrane recycling. Summary: Annular gap junctions were tracked to determine their fate. They divided, changed shapes, associated with membrane organelles and possibly recycled. The frequency of these events is being determined. Such information will increase our understanding: of gap junction protein turnover; and the role of annular gap junctions in protein delivery to other organelles.

SBI132: Mars' soil and the development of plant growth

For this experiment, I will be using thirty pots to plant bean plants in. The first fifteen pots will be my control variable, while the other fifteen pots will contain the simulated Mars soil. Instead of having to be in a laboratory environment, to help simulate the soil composition of Mars, I will be using safe household substances that can replace the true chemical compounds found in Mars' soil. Substances used will be, iron supplements, calcium supplements, a sulfur-based plant fertilizer, In all of the pots, there will be a bean plant grown due to the fact that beans are an easy plant to grow. I will observe the plants until a sprout has occurred. Once a sprout has begun, I will compare the control to the simulated soil to see if growing plants on Mars can be possible. By the time of experimentation, I will be using a greenhouse to help speed up the growing process. Inside the greenhouse, I will also attempt to simulate the atmosphere that Mars holds, to help with the data.

SBI133: Fertilizer Source Influence on Algal Growth

Eutrophication is a huge problem in the world. Many marine animals have died, fisherman can't support their business, and dead zones will be present for many years. The main cause of eutrophication is the runoff of fertilizers. In my experiment, I will test the effects of fertilizers as well as seeing which type of fertilizer causes a bigger algae bloom. The two types of fertilizers that I will be using is organic and inorganic. I will put the fertilizers in liquid form and put them in separate tubes. All of the tubes will be 5 ml with 2 ml of Chlamydomonas algae, 1 ml of algae grow, and the spring water will vary depending on the amount of fertilizer. The fertilizer will be disturbed into 4 categories with the 1 category being 0 ml (control), 0.01 ml, 0.1 ml, and 0.5 ml. In order to measure the data, I will use a spectrometer and set it to 430 nm and an absorption. Before measuring each tube, I will mix them, so I get a better reading. Then I will blank the machine and measure each tube. After 14 weeks I will stop taking readings and finalize my project by reviewing the data and putting it into a presentation.

SBI134: Using Algae to capture carbon: The combined Influence of species choice and light duration/type

There is too much CO2 in our atmosphere, causing temperatures to rise and the health of our planet to decline. My experiment explores a method to combat this using CO2-consuming microalgae supported using solar power-based growth tanks designed to maximize the amount of carbon that can be captured in places with lower levels of light. My work compares multiple variables to find out how to get the most CO2 out of the air while using the most beneficial combination of light duration and heat in controlled growth boxes. To understand what combination of plant species and light/heat input works best, I used three variables: type of algae, duration of illumination, and water temperature. The two species of microalgae I am using are Nannochoropsis and Chlorella Vulgaris. To gauge growth rate, I am testing each sample with a photo spectrometer every three days, and I also am drying and weighing each sample at the end of the test period. Finally, based on my findings, I will propose an idealized solar-powered CO2-capturing system based on Algae. Experimentation is continuing, and results will be available on a fair day.

SBI135: The Effects of L-glutamine on Drosophila melanogaster

I have noticed many people at my local gym take the supplement L-glutamine. I researched and found that L-glutamine may increase the human growth hormone and promote the production of lean muscle mass. This made me curious about how effective this supplement is. During my research, I also found that Drosophila melanogaster is a model organism for biological research. I decided to test the effects of L-glutamine on Drosophila melanogaster. Procedure Used I ordered cultures of D. melanogaster. I waited until pupae were present in the culture vials and anesthetized the adults and removed them. This was to ensure I was observing the new generation of D. melanogaster. I waited for the pupae to turn into adults and used these for my project. I placed five D. melanogaster in each vial. Each vial contains a medium concentration with L-glutamine. I had two groups. My exposure group contained L-glutamine. The control group did not contain L-glutamine. Data was collected at the end of 14 days. Data Observations are the weight of the D. melanogaster.

SBI300: In Vitro Antagonistic interactions in Cordyceps militaris

The Cordyceps genus of fungi is currently used in some pharmaceuticals. The compound commonly used is Cordycepin produced by the Cordyceps. The cordycepin is a nucleoside analogue that only runs in the 3' direction. The cordycepin attaches to the lagging strand of DNA in replication or an mRNA transcript. In this experiment, the viability of C. militaris as a fungicide, and antibiotic will be tested. The mycelium of C. militaris will be placed in an environment with other competing species of fungi and bacteria. This experiment will measure the diameter of the growing colonies to see the effects of antibiotic properties of C. militaris on antagonism between other species of fungi.

SBI301: Structural Modeling of Cytochrome P450 4F11, A Potienial Cancer Drug Target

An ensemble of possible models of enzyme Cytochrome P450 4F11(CYP4F11), which does not have an experimentally resolved structure, were generated using the artificial intelligence Alphafold, Now, molecular docking program Gnina is being used to predict where and how the substrates arachidonic acid, HETE016, and erythromycin may bind to CYP4F11. Introduction: Emerging research indicates that enzyme Cytochrome P450 4F11's metabolism of various fatty acids may be linked to lung cancer proliferation and growth. The inhibition of CYP4F11 may be useful to treat cancer, but to develop inhibitors of a protein its structure must be resolved. As of now, CYP4F11's structure has not been experimentally resolved, but computational methods can create a relatively accurate prediction of what CYP4F11's structure may be. Methods: We constructed structural models of the Cytochrome 4F11 protein (CYP4F11) bound to the three different substrates: erythromycin, arachidonic acid, and HET0016. To do this, we first used a website called Uniprot that allowed us to look at the amino acid sequence for the CYP4F11 protein. We then downloaded the sequence and used a program called protein blast that allowed us to compare the amino-acid sequences of other structures and find ones that were the most similar to that of the CYP4F11 protein. After identifying these similar structures we used Pymol which is a molecular visualization system that allowed us to compare these similar protein structures to the CYP4F11 enzyme three-dimensionally. The next thing we did was use Alphafold which is a fairly new artificial intelligence program developed by DeepMind that allows its users to generate 3D predictions of protein structures. We then used the Alphafold program to generate an ensemble of structures of the CYPF411 enzyme. Lastly, we used Pymol to visualize each of the generated structures aligned with the substrates Erythromycin, Arachidonic Acid, and HET0016 to see which generated structure of CYP4F11 aligns best with the substrates. Results: We have created a diverse ensemble of possible CYP4F11 configurations, complete with a heme, and a root mean square fluctuation comparison of their differences from a similar protein, CYP4B1. To finalize these models, we must make a prediction of where each possible substrate will lie. We are currently using Gnina, a molecular docking program, to give each prediction in our ensemble a prediction for how each substrate may bind. Discussion: These models could serve as a baseline for further study into CYP4F11 and its metabolism of fatty acids. Further diversification and curation of CYP4F11 models is in progress. Eventually, these models could be replaced by experimentally resolved crystal structures of CYP4F11.

SBI302: Effects of Electricity on Plant Growth

Compared to a controlled variable of plant growth, we will experiment to determine the effects of electricity on plant rate of growth.

SBI303: Hydroponic Garden

For our project, we will be producing a hydroponic garden. We plan to construct this vertical garden using PVC pipe and different liquids to possibly grow them in. We will determine from the results which liquid encourages the most growth.

SBI304: Monkey Sea Monkey Dye

Please visit student's exhibit for abstract

Chemistry (SCH)

SCH100: How different leavening agents affect the height of cupcakes

The goal of my project, titled 'How Different Leavening Agents Affect the Height of Cupcakes,' was to determine which leavening agents would result in the tallest cupcakes and which ones would be most effective in a cupcake recipe. I hypothesized that if comparing the height of the cupcakes after baking, then the baking powder will yield the tallest cupcake. For my procedure, I used a basic cupcake recipe. When doing the test groups, I only made adjustments to the steps and ingredients when the leavening agents were added. My control groups were baking powder + vinegar, baking soda + cream of tartar, baking soda, active dry yeast, rapid-rise yeast, and the control, which had no leavening. The cupcakes with the two kinds of yeast added to them rose because of alcoholic fermentation. The other test groups had an alkaline and an acid added to them; when added, a process called chemical leavening occurs. The cupcake made with baking soda and cream of tartar had the tallest height at 5.1 cm. The cupcake with rapid-rise yeast had the smallest height at 4.3 cm. My data suggests that baking soda and cream of tartar are the most effective leavening agents for achieving a tall cupcake. After experimenting, my data rejected my hypothesis.

SCH101: Orange Juice and Vitamin C

Vitamin C, or ascorbic acid, is a crucial antioxidant that plays an important role in human health. As the primary source of vitamin C for many individuals is citrus fruits, understanding the variability in vitamin C levels among different orange juice brands is essential for consumers. The experiment involved the collection of several popular orange juice brands, categorized as fresh-squeezed, concentrate, and pasteurized to represent diverse processing methods. The vitamin C content of each sample was determined through titration with a standardized solution of iodine. The endpoint of the titration was determined using a starch indicator, allowing for accurate measurement of the ascorbic acid concentration in each juice type.

SCH102: Contents of Non FDA-Approved Vitamins

Over half of all United States citizens regularly consume over-the-counter supplements. However, none of OTC supplements are regulated by the Federal Food and Drug Administration. My project seeks to prove that over the counter supplements will contain inaccurate amounts of the ingredients used to manufacture them. Eight different supplements will be ground into a fine powder, acidicly broken down, and analyzed via inductively coupled plasma mass spectroscopy. My project hypothesizes that out of eight OTC supplements, at least half of them will contain significant inaccuracies when the actual contents are compared to the label's statement. Once I have prepared all of my samples I will then compare my samples to liquid metal standards which will serve as a baseline for my findings. The data that is collected will be used to determine methods of further research and testing to identify inaccuracies during manufacturing of OTC medication. 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.

SCH103: How can plastics be decomposed faster and in an eco-friendlier way?

Polyethylene plastic is one of the most common types of pollutants in the modern world. It is collectively transported to landfills in large quantities and takes several centuries to degrade, releasing harmful greenhouse gases such as methane and ethylene in the process. Microplastics negatively affect aquatic and human health as well. I examined three different eco-friendly methods of degradation, namely UV light exposure, water immersion, and heat exposure. I hypothesized that UV light exposure would be the best method to degrade plastics. The results showed that UV light exposure and heat exposure were the most effective methods in plastic degradation.

SCH104: Conjugation of Antibodies to Magnetic Beads for Cancer Detection

Currently, over 90% of cancer patients succumb to tumor metastasis. Therefore, detecting cancer before it reaches this critical stage is imperative for effective treatment. However, existing assays are hampered by a lack of sensitivity and specificity. This project aims to address these limitations by developing an innovative method for isolating cancer-derived materials from blood samples. The focus of my research involves the conjugation of cancer-specific antibodies onto magnetic beads. Through systematic experimentation, I have explored the optimal conditions to achieve this conjugation successfully. My results indicate that by employing cancer cell-derived samples spiked in artificial plasma, I can effectively capture cancer cell-derived materials with high efficiency, while selectively rejecting non-cancer-cell-derived materials. This breakthrough holds promising implications for the development of a more reliable and accurate blood assay for early cancer detection, ultimately contributing to improved patient outcomes.

SCH105: Effectiveness of Simple Water Filters on the School's Water Quality

Few students these days would drink from the school's water fountain mainly because of unfavorable taste. Thus, school trash cans would be filled with the water bottles sold during lunch. This led to a large amount of plastic waste in the trash and extra expenses that students could save. This study aims to find out simple filtration methods' positive effect on the taste of the school's intricately filtered water, as well as the best simple filtration method. To determine quantitatively the quality of the water, e.g., taste, I used the variables, pH, total alkalinity, and the water's hardness. To find cost-effective methods that could lower the water's hardness, and raise the pH and total alkalinity to a reasonable amount, heating, electrolysis, and NaHCO filtration were used to compare the filtered water with control water. The results displayed heating filtration having the largest decrease in the water's hardness, electrolysis increasing the pH, and NaHCO raising the total alkalinity to an advisable amount. All three filters are observed to improve the school's water quality. From the current study, heating filtration is the best filtration method for the taste of school's water. Experimentation is continuing, and results will be available on fair day.

SCH106: The Effect of Different Substances Used in Electrolysis to Increase Hydrogen Production

In the real world, hydrogen production is becoming more and more popular as technological advancements occur. In the past, scientists have used graphite and found it to be better and more cost-effective. But not enough testing has not been done to put it to real use yet. If electrolysis is performed using graphite as an electrolyzer, there will be more hydrogen bubbles. Electrolysis was performed with graphite electrodes, saline solution, and acetic acid to see which one would enhance the separation of hydrogen and oxygen in the water. If there is a certain variable that can enhance the production of hydrogen, this can be amplified to real world problems and production. Most of the hydrogen consumed in the United States is used by industry for refining petroleum, treating metals, producing fertilizer, and other chemicals, and processing foods. Hydrogen can be used to power vehicles, generate electricity, power industry, and heat our homes and businesses. It could make a huge difference on our carbon emissions and will be critical to achieving net zero.

SCH107: Comparing The Effects of Aspirin and Willow Bark

Many modern medicines used in our healthcare system today have been derived from natural sources such as plants, bacteria, and fungi. The focus of this experiment is to measure and compare the effects of aspirin and its natural derivative, willow bark, on certain systems of the body. For this project, aspirin and willow bark will be used in three separate experiments in order to demonstrate their effects. The three factors tested include, pH changes within an environment similar to the stomach, air pressure changes within a closed environment similar to the stomach, while also determining the medications' effects on clotting factors within the bloodstream. Experimentation is currently in progress and further study will be conducted in order to form a more definitive conclusion before presentation.

SCH108: The Effect of Chemicals in Pool Water on the Durability of a Swimsuit

The intent of this experiment is to measure how the chemicals in pool water break down and change the tensile strength of a swimsuit and determine which swimsuit brand is the most durable. Three brands of men's speedos (Speedo, Sporti, iSwim) were sampled. It was hypothesized that Speedo would be the most durable. A 7x7 cm sample of fabric was taken from each suit. The fabric was stretched 15 cm and the force (N) required was recorded. Samples of pool water were divided into four containers and chemical composition was tested individually. The speedos were soaked in pool water for ten days. A control was kept. Both the suits and the water were left untouched for the full ten days. At the conclusion of ten days, the suits were removed. The force (N) required to stretch the fabric 15 cm was recorded again, as was the chemical composition of the water samples. Chemical levels in every water sample decreased the same amount. The tensile strength of Sporti decreased from 10 N to 9 N and iSwim decreased from 9 N to 8 N. Speedo exemplified a tensile strength of 10 N before and after, causing the hypothesis to be accepted. It was concluded that the water samples' chemical compositions decreased the same amount because chemicals were not added throughout the experiment to keep the levels consistent. Speedo was the most durable suit, as it showed the least change in tensile strength.

SCH109: Heat Protectant - Bust or Must?

The purpose of my project Heat Protectant: Bust or Must? Is to test if heat protectant is really worth the hype it gets. I am going to use samples of hair to test if split ends are caused when heat is put onto the hair. The independent variable is going to be the inclusion of heat protectant and/ or the brand of heat protectant. To analyze my data I am going to make a digital chart providing images of hair with different amounts of split ends. The images will be labeled with variables such as A, B, and C. For example, A could represent no split ends occurring, while B shows a few, and C shows more. The final results of my project will be available at the fair.

SCH110: Gold Recovery from Electronic and Jewelry Waste

Gold is a noble metal with unique electrical, chemical, and catalytic properties. Because of its high value, gold recovery from electronic and jewelry waste is desirable. In this experiment, two methods of gold recovery were studied, and their efficiency was compared. The electronic and jewelry waste was disassembled, cleaned, and subjected to acid leaching in both experiments. The auric acid was formed and then reduced to yield gold powder. After precipitation, the gold powder was washed, melted in an electric furnace, and weighed. The main difference between the two methods is the choice of reducing agents - stannous chloride or sodium metabisulfite. The design of the experiment was used to optimize the gold recovery in each method. The sodium bisulfite method produced 98% yield compared to 80% yield of the stannous chloride method. The lower yield of the stannous chloride method is likely due to the formation of colloidal gold particles, which impede precipitation. Keywords: Gold, recovery, oxidation, aqua regia, stannous chloride, sodium metabisulfite.

SCH111: Cleaning Products' Effects on Blood Forensics

The purpose of this experiment is to determine if any certain cleaning product (s) are able to clean synthetic blood well enough to trick a blood luminol test. Instead of using real blood, synthetic blood was created by mixing iron (III) chloride and potassium thiocyanate to create iron(III) thiocyanate, which simulates the hemoglobin in blood. The hypothesis is that out of the cleaning products tested (Clorox bleach, Dawn dish soap, and Lysol all-purpose cleaner), bleach will be the only one that can clean up synthetic blood without leaving a trace. After the flooring and cleaning products were obtained, the fake blood was created and the luminol solution was made. This experiment was performed by first putting two mL of synthetic blood on a piece of laminate flooring, and letting the blood sit for one minute. Then simulated blood was then cleaned using the tested cleaning product. Lastly, the luminol solution was sprayed onto the laminate flooring. After the experiment had concluded, the laminate flooring piece was sanitized and disposed of properly. Results were then recorded and analyzed. Final results available at fair.

SCH112: The rate of fingerprint deterioration due to continuous applications.

Fingerprints are a primary piece of evidence for crime scenes and are an important part of forensic science. Forensic scientists use a biometric factor known as minutiae, which are specific details in friction ridges, to identify fingerprints. These same forensic scientists are constantly looking for what more they can use fingerprint information for. The deterioration of fingerprints due to continuous application: how the amount of identifiable minutiae changes dependent on the amount of prints placed. The goal of this study was to create a better understanding of why a found fingerprint may be The 90 prints were placed and then dusted with magnetic latent print powder, then they were photographed and the fingerprints minutiae were analyzed. The prints were all placed in the course of half an hour, dusted in the course of an hour and analysis of those prints took a week to complete. The data suggested a trend of decreasing identification; the steepest drop in identification rate being at the 39th print, which rejected my hypothesis that the identification rate would have the steepest drop at print number 30. I was able to conclude that there is a specific point at which the amount of visible minutiae drops to such a low number that it becomes more difficult to identify the print. Future studies are being planned as to allow for more trials as well as potentially a more accurate method of measuring minutiae deterioration.

SCH114: Does layering of SPF better protect against UV?

The purpose of my experiment is to see how different layers of SPF better protect against UV radiation. I used two Petri dishes, one for SPF 15 on one side and then SPF 30 on the other side. The second dish was used for SPF 15 on one side and then SPF 30 on the other and then used a thin layer of lotion. A ring stand was used to elevate for testing a mini UV light source was put under the Petri dish will be the Vernier spectrophotometer with optical fiber attached to the calibrated spectroscope and then measure the amount of UV that penetrates through both dishes. Data showed that as I layered the SPF and lotion, the amount of UV emitted through the dish decreased. This concluded that adding levels of SPF helps protect against us UV rays.

SCH115: Usnic Acid Extraction in Lichens

Usnic acid is among the most important and interesting chemicals produced during the metabolism of lichens. Lichens containing usnic acid have been found to possess antibiotic properties, and the compound has been used as an active agent against several bacterial organisms, such as staphylococcus, and to treat tuberculosis and serious skin conditions. Recently, it has proven to be effective in combating a large number of Gram-positive bacterial strains - notably inhibiting the growth of streptococcus aureus, enterococci, and mycobacteria, which are known to cause skin and soft tissue infections, meningitis, wound infections, tuberculosis, leprosy, and other dangerous infections and diseases. Chemists have also found that the acid has potential to destroy human cancer cell lines by affecting the mitochondrial and lysosomal function of cancerous cells. Despite these important properties, little research has been done to analyze the environmental factors affecting the production of the compound in lichen species. In order to best understand how to maximize the yield of the acid in extraction, this experiment investigates whether lichen samples exposed to more sunlight yield different amounts of usnic acid than those growing on trees exposed to less sunlight. Lichen samples growing on trees living in open and more forested areas of Riding Meadow Park in Fox Chapel, Pennsylvania were collected. Usnic acid was extracted from these samples using acetone and samples were analyzed using an IR spectrometer. Data collection is still ongoing. Results comparing the yield of usnic acid in the lichen samples will be presented at the fair.

SCH116: Utilizing Machine Learning to Model Interdependency of Bulk Molecular Weight, Concentration, and Thickness of Spin Coated Polymer Thin Films for Predictive Applications in Materials Engineering

Spin coating is a widespread and inexpensive method to create nanometer-thick polymer films. The process involves the deposition of a liquid polymer solution onto a solid substrate followed by rapid rotation, solidifying a uniform film onto the substrate. Polystyrene is an amorphous polymer often spin-coated for applications in the semiconductor, biomedical, and lens coating industries. Since film thickness determines mechanical, optical, and degradation properties, several groups have previously derived equations to predict final thickness. However, these equations intrinsically contain high error due to the large number of complex variables. Therefore, it is imperative to develop a simple method to predict thickness based on a few easily manipulatable factors. In this study, the interdependent relationship between solution concentration, bulk molecular weight, and film thickness was determined through novel machine learning-based 3D manifolds simultaneously relating these variables. Of the ten machine learning models assessed, the Curve-Fit manifold performed the best in modeling the relationship, exhibiting a Root Mean Squared Error (RMSE) of 1.37 and Mean Absolute Percent Error (MAPE) of 6.70%, while also exhibiting individual 2D slice relationships that agree with fundamental polymer theory. Regarding predictive capabilities, the model can receive bulk molecular weight and desired thin film thickness as input and output predictions of the polystyrene solution concentration required to generate a certain thickness. When tested with new solution combinations, the Curve-Fit model was able to predict the necessary concentration with an RMSE of 1.34 and MAPE of 4.55%, suggesting significant applicability in advancing precision film design.

SCH117: Capsaicin Content: One Chip Challenge vs Common Foods

Please visit student's exhibit for abstract

SCH118: Optimizing Process Parameters for the Manufacturing of Anti-HSV Films

Please visit student's exhibit for abstract

SCH119: Adsorption vs Absorption in water treatment

This project aimed to investigate and compare the efficacy of adsorption and absorption processes in removing contaminants from water, with a focus on enhancing water treatment strategies. The purpose of this experiment is to examine the strength and weaknesses of both methods. The procedure used involves running the contaminated water through both the adsorption and absorption methods. The contaminated water contains a series of contaminants including food coloring, vegetable oil, fine particles, organic compounds, etc. The adsorption method includes using activated charcoal. The absorption method includes using sand, gravel, regular charcoal, and cellulose base substances.

SCH300: Electrolytes in Sports Drinks

Compare the amount of electrolytes in a sports drink with those in other beverages to find out which one has more electrolytes to replenish the ones you lose as you work out or play sports.

Computer Science / Math (SCM)

SCM100: A Synthetic Approach for Mucus Plug Identification on CT Images to Evaluate Treatment Efficacy

Mucus plugs, excess buildup of mucus secretions in airways, emerge as a potential therapy target in obstructive lung disease (OLD), such as asthma and chronic obstructive pulmonary disease (COPD). Recently, ongoing efforts in developing medicines for mucus plug clearance have accelerated. However, an accurate and efficient method for quantifying mucus plugs to validate treatment efficacy is lacking. Current approaches rely on manual identification of mucus plugs on computed tomography (CT) scans but are time-consuming, error-prone, and expensive. While deep learning-based image segmentation algorithms are promising approaches to alleviate laborious manual identification, achieving high accuracy requires a sizeable dataset with annotated abnormalities. This study proposes using synthetic data to develop the first deep learning model for automated mucus plug segmentation on CT scans. An algorithm was developed to synthesize mucus plugs on CT scans, eliminating labor-intensive and expensive manual annotations. A state-of-the-art convolutional neural network (CNN) was trained using the synthesized mucus plugs for automated mucus plug segmentation. For comparison purposes, an additional model was developed and trained using manually annotated mucus plugs. When validated in real-world cases, the synthesis-based model achieved superior performance with a sensitivity of 0.837 and a false positive rate per CT scan of 1.91, outperforming the annotation-based model. The synthesis-based tool offers a cost-effective and time-efficient approach for personalized diagnosis and treatment assessment in OLD. Currently, this tool is under evaluation for a clinical trial sponsored by Regeneron Pharmaceuticals Inc. to assess therapeutic efficacy on mucus plug clearance in asthma individuals.

SCM101: Optimization of Breast Cancer Screening Facility Location for Rural Areas Using Statistical Choice Model

The purpose of the research is to optimize breast cancer screening center locations for rural areas. The accessibility of breast cancer screening centers is crucial for the health of women within the age range of 40-60. However, due to the rural-urban disparities in access to cancer screening centers, rural areas are known to have a substantial proportion of women diagnosed with distant breast cancer compared with women from suburban and urban areas. Rural regions have a small-scale population, clustered spacing, and a limited budget due to the contrasting amount of taxes when it comes to acquiring preventive healthcare facilities such as breast cancer screening centers. The model can be used to aggregate the healthcare budgets of multiple rural communities to collaborate and install an achievable number of breast cancer screening centers with optimized locations. Using a statistical choice model, the optimal locations for screening centers within the rural communities near Pittsburgh, PA (example input), can be determined, maximizing the expected number (called demand) of women who utilize the centers. The optimization model enumerates all the choice sets and selects the choice set of the maximum demand. To compute the demand of each choice set, we compute the utilities of the screening centers based on the literature, which induce their choice probabilities. The model can be applied to calculate optimal locations for breast cancer screening centers in rural areas of supplementary regions as advised.

SCM102: Enhancing SLAM Algorithm Performance through Novel Training Techniques for Flow, Stereo, and Depth Estimation in Unified Transformer-typed Computer Vision Models

Please visit student's exhibit for abstract

SCM103: Geometric Self-Supervised Learning: A Novel AI Framework Towards Quantitative and Explainable Diabetic Retinopathy Detection

Diabetic retinopathy (DR) is the leading cause of blindness among working-age adults. Early detection is crucial to reducing DR-related vision loss risk but is filled with challenges. Manual detection is labor-intensive and often misses tiny DR-lesions, necessitating automated detection. However, existing automated systems are rarely used in clinical practice, solely classifying DR severity into different groups through an uninterpretable black-box process without providing valuable quantitative insight for precision medicine applications. In contrast, a quantitative detection system that identifies individual DR-lesions would overcome these limitations and enable diverse applications in screening, treatment, and research settings, but remains impossible to develop. The reason is that manually annotating diverse lesions is extremely time-consuming and challenging, limiting the amount of reliable data available to train an accurate model. To address this issue, this study presents geometric self-supervised learning, a novel framework for training a deep learning model without any manual annotations as ground truths to detect and segment the four most prevalent types of DR-lesions (i.e., microaneurysms, hemorrhage, hard exudate, and soft exudate) on retinal images, making it possible to utilize the millions of retinal images available for training. Geometric rule-based vision algorithms are utilized to identify and differentiate high-probability normal/abnormal regions and then extract image patches for training a U-net model. This novel framework was extensively verified on two public datasets, significantly outperforming all available studies in detecting and segmenting DR-lesions. It enables self-supervised training of any AI model to detect and segment DR-lesions, and its mechanism is generalizable to other segmentation tasks.

SCM104: Using Machine Learning and Video Analysis for ASL Translation

I am developing a machine learning (ML) program that converts American Sign Language (ASL) into text in real time. The purpose of this project is to increase communication between people, and therefore increase inclusion for people with communication disorders. The procedure first starts with the video system, which is made by connecting the python file to the html file using Flask. Then, utilizing the openCV functions, the webcam is activated and displayed on the html file. Through Flask, the python file receives the recording in real time, and divides into frames by using the openCV module. The video is also automatically saved into the user's files for further analysis. The custom ML model requires data, which is why I am using Microsoft's open dataset of 10,000 ASL videos. The ML model will receive 70 percent of this dataset to train this model, and 30 percent for testing. The official target of this program is to reach 90 percent accuracy or higher. The ML model will then analyze each frame, and output the translation onto the HTML file, along with a text to speech software utilizing the gTTS module. This project contains potential risks of mistranslation, catastrophically leading to decreasing communication and ruining someone's integrity. To minimize such risks, I am training the model with awareness of such steps of misinformation. In conclusion, my project is an ML model that translates ASL into English text, with the goal of increasing conveyance and inclusion for people with communication disorders.

SCM105: Skin cancer detection using machine learning

Given the remarkable success of Deep Convolutional Neural Networks (DCNN) in diverse Computer Vision tasks like image classification and object detection, its application has expanded into various domains. Notably, Esteva et al. demonstrated in Dermatologist-level classification of Skin Cancer with Deep Neural Networks that a CNN achieved performance comparable to dermatologists, marking a significant advancement in skin cancer classification. Motivated by this breakthrough, this project focuses on fine-tuning pre-trained DCNNs, such as VGG16, Inception V3, Inception ResNet V2, and Dense Net 201, renowned for their success with the ImageNet dataset. The objective is to classify seven types of skin lesions using the HAM10000 dataset, consisting of 10,000 dermatoscopic images. Fine-tuning the top layers resulted in similar test set accuracies for VGG16 and Inception V3, achieving 79.64% and 79.94%, respectively. Inception ResNet V2 outperformed them by 3%, while Dense Net 201 yielded the best single result with an accuracy of 83.93%. Subsequently, fine-tuning the entire model was performed with Inception V3 and Dense Net 201. After 20 epochs, although Inception V3 slightly outperformed on the validation set, Dense Net 201 achieved the highest accuracy on the test set at 87.725%. These experimental results validate the notion that features learned by pre-trained models, coupled with the architectures of DCNNs, contribute significantly to learning features for distinct datasets, such as dermatoscopic images of skin lesions. Considering computational efficiency and test accuracy, fine-tuning the entire pretrained model with fewer epochs emerges as a superior strategy for this specific dataset.

SCM106: PCA - Principal Component Analysis

Everybody experiences irritation when the program they are opening is too slow or they are given too many variables to analyze. This is the curse of dimensionality, where too many variables makes the program slow and difficult to follow while having too little variables makes the program too simple and with poor outcomes. There are many different ways to eliminate dimensions like backward feature elimination, missing value ratio, low variance filter, and principal component analysis (PCA). Of this, I hypothesized that PCA will be the most efficient and precise method to eliminate dimensions. To test the four methods two data sets were used. The first one measured cholesterol, taking multiple different factors into account. Next, a machine learning program was made to calculate the cost of houses in Pennsylvania. All methods were then rated on efficiency, with the lower numbers meaning that the process takes lots of time with a poor performance when compared to the actual dataset. The experiment proved that different circumstances require different methods to be used. While a particular method is the best when eliminating variables in a certain data set, it could be very bad at another data set. Also, no method will give a perfect result. Since data is being removed, the performance will be affected and it is important to be able to decide how many variables should be removed, too many variables will change the output of the variables while too little variables will mean that the curse of dimensionality still exists.

SCM107: Applying DDTL to Enhance Infectious Disease Case Detection

Please visit student's exhibit for abstract

SCM108: Bayes' Theorem in Medicine

Many times people hear and read statistics in medical articles that are about certain diseases. Many times though, they do not fully understand what they mean because they can easily be misinterpreted. This uncertainty leads to confusion and fear. In this project, I wanted to explore more into the topic to get a better understanding of what these statistics truly mean. In order to accomplish this, I researched topics in probability and completed many practice problems to understand the underlying math. I then applied those concepts to several different scenarios. If I decide to pursue a career in medicine this information can help me understand and become a more effective communicator. Also, with a better understanding of probabilities, people in the medical field can become better at explaining to the patients exactly what is going on.

SCM109: Using Machine Learning to Identify Lanternfly Eggs

Lanternflies are an invasive species in many regions across the globe. In these regions, they have no natural predators, and thus nothing stopping them from exponential growth. This project uses machine learning based image classification to detect lanternfly eggs reliably. By detecting lanternfly eggs reliably, it can help stop the massive growth of the lanternfly population. A Keras (tensorflow neural network) model is being trained using images from the web representing the positive (lanternfly eggs present) and negative classes (lantern fly eggs absent). The model is given about 80 images containing lanternfly eggs in the positive class and 80 images containing lanternfly egg lookalikes, or tree bark in the negative class. Furthermore, the classes were split into two separate datasets, the training and the testing datasets. The training dataset, consisting of images from both the positive class and the negative class, is used to train the model to recognize lanternfly eggs. The testing dataset, consisting of 20 images from each class, is used to evaluate the model. When the program was run, the model achieved an accuracy of 80% accuracy and 90% true positive rate. This project expresses the need to stop this massive growth of lanternflies and provides a potential solution to help solve this problem reliably.

SCM110: EnViD: A Novel low-compute Predictive Vision Pipeline with Temporal Contrast for Single Object Tracking in Dynamic Visual Fields Embedded on GPU

Autonomous unmanned vehicles (drones, self-driving cars, etc.) require fast and efficient perception and control to perform in dynamic and unpredictable real-world environments. Comprehending visual reality requires the efficient acquisition of common-sense knowledge over several regularities in the visual world, e.g., object spatial relationships, temporal dynamics such as motion and rotation, and illuminations on objects in view. In the realm of computer vision, a paramount challenge resides in the performance of vision systems within such dynamic environments, where conditions such as glare and shadows markedly affect their efficacy, particularly in the domain of Single Object Tracking (SOT). The prevailing methods, while sophisticated, are hindered by large data sets and high computational demands with their performance being compromised under varying ambient conditions. Considering these challenges, a novel event-based predictive vision algorithm (EnViD) was developed to better capture such real-world dynamics. EnViD builds sophisticated and meaningful high-to-high associations, in comparison to high-to-low associations (image to class). In doing so, it creates semantically meaningful features, which can then be associated with some more abstract and low-dimensional concepts through a predictive vision algorithm. To address the high computational challenge from typical frame-based vision, a temporal contrast signal processing method (event-based vision) was applied, similar to contrast in the eye's retina, resulting in the removal of 92% of the data used. This event-based predictive vision algorithm was tested using real-world data including occlusions and shadows using NVIDIA Jetson Nano. The results consistently exceeded current accuracy, success, and precision benchmarks.

SCM111: Using a modern generative AI algorithm for predicting the missing parts in fossil images

In this research project, I explore modern generative AI models for filling in missing pieces in fossil images of common 40 clades. In paleontology, fossils are often found incomplete with missing parts due to the nature that fossilization phenomenon is very rare. I investigate one of the state-of-art generative AI models, Masked Auto Encoder (MAE), for inpainting missing parts of fossil images. The challenge is that the existing generative AI models including MAE are usually trained with general datasets such as ImageNet/Scene datasets therefore those models do not learn about fossil datasets and their performances are suboptimal. For improving reconstruction accuracy, I retrain the MAE model with 450K fossil images (Fossil-MAE) and compare its image reconstruction performance with a baseline model that is trained with ImageNet dataset (ImageNet-MAE). For testing, I randomly select 32 test images from 16 fossil clades and measure reconstruction accuracy of Fossil-MAE and ImageNet-MAE while changing 1) the position of masked pixels and 2) the amount of masked pixels. RGB loss (RMSE) is used for measuring the reconstruction accuracy. My experiment results show that Fossil-MAE outperforms ImageNet-MAE by 11.5% on average and Fossil-MAE performs more stably than ImageNet-MAE. Fossil-MAE has 3 times lower standard deviation than ImageNet-MAE.

SCM112: Prediction of Population Growth in an Ecosystem through Computer Science

This project was designed to see if the growth of a population in an ecosystem can be accurately predicted by a computer program. Multiple factors that influence population growth are taken into account. Growth is ultimately predicted using multivariable regression. Accuracy will be tested by observing previous population data from one time to another in an ecosystem.Experimentation is still ongoing but will be completed by the fair.

SCM113: A Novel way to improve the prediction of heart disease using big data and AI machine learning

The purpose of this project is to improve the prediction of heart diseases using big data and an Ensemble AI machine learning software product. First, various key risk factors of heart disease will be collected from various sources, analyzed thoroughly, and documented. A few sets of big data of anonymous medical records specific to those risk factors will be extracted from publicly available data sources, and the best big data will be selected for the project. Various AI machine learning algorithms will be analyzed, and a few of the best algorithms will be selected for the project. A heart disease prediction software product will be developed using AI machine learning algorithms and big data. The big data will be divided into various datasets for the experiments. The entire set of big data will also be used to do experiments. Various software modules will be developed using those datasets and individual AI machine-learning algorithms. In a specific software module, an AI machine learning algorithm will be used against one of the datasets, and the corresponding AI machine learning model will be developed from it. This step will be repeated for the combination of every individual dataset and every AI machine learning algorithm and the entire set of AI machine learning models will be developed from it. The accuracy of the prediction of heart diseases will be generated for each model and the accuracy of all models will be compared against each other. All data and results will be documented. Ensemble AI machine learning models will be developed using those source AI machine learning models and the corresponding datasets. The accuracy of the heart disease prediction of ensemble models will be measured and documented. The accuracy of the heart disease prediction of ensemble models will be compared against the accuracy of the heart disease prediction of the corresponding source models, and the results will be documented. All data and results will be gathered, documented, and compared to test if the ensemble AI machine learning models improve the prediction of heart issues compared to individual AI machine learning models.

SCM114: Developing a low-cost fall detection and alert system

Please visit student's exhibit for abstract

SCM115: Homology Analysis of SLP-2 (stomatin-like-protein 2) in Eukaryote

Stomatin-like-protein 2 (SLP-2) is a relatively newly discovered stomatin homologue with unknown functions. SLP-2 is found in the mitochondria and red blood cells (erythrocytes). Using bioinformatics to analyze amino acid sequences of proteins provides researchers and medical professionals with insight into diseases and health, as they can draw conclusions about the gene's functions. In this case, bioinformatics can be used to analyze SLP-2 among various species to understand the gene's foundations. In order to analyze the sequences among various species, sequences need to be gathered from the NCBI (National Center for Biotechnology Information). Then, the sequences should be in the format of FASTA so that they can be analyzed. Using CLUSTAL software, the sequences of various species are aligned and can be compared to one another. Since some species, including homo sapiens and mice, are missing 5 sequences from the same spot, it can be concluded that due to natural selection, the SLP-2 protein in these species were changed in similar ways. Although these species come from a common ancestor, they diverged paths in evolution, as some sequences are still different. As a result, the hypothesis that using bioinformatics to align sequences of a protein to get a better understanding of the gene's function and structure is proven. From bioinformatics, the foundations of the gene in different species results in further knowledge about how the SLP-2 sequence changes with evolution. In the future, technology will improve, and new algorithms will be introduced; thus, there will be advanced methods to analyzing the function and structure of unknown genes, which will improve the findings of scientific research and knowledge about health and disease.

SCM116: Modeling Youth Substance Abuse Using Markov Chains

In recent years, the amount of drug overdoses amongst teenagers has noticeably increased. Mathematical models can be used to analyze and predict youth substance abuse patterns. Most previous models of the spread of youth substance abuse have been based on systems of differential equations. This project proposes a discrete Markov model in which individuals are placed in one of five categories based on their frequency of substance abuse. Data from the National Institute on Drug Abuse is fed into the model to yield predictions about how youth substance abuse patterns change over time and to make predictions on the effectiveness of certain mitigation strategies. Although the predictions generated by the model are not always accurate, they demonstrate that a Markov model can be used to simulate the spread of youth substance abuse given enough data.

SCM117: Utilizing Machine Learning for Euler Angle Analysis in Pediatric Facial Recognition to Identify Autism

Autism Spectrum Disorder (ASD), a complex neurodevelopmental disorder characterized by difficulties in social interaction and perseveration, typically manifests symptoms as early as 18 months old. Despite the advances of modern medicine, the ASD diagnoses of countless children are neglected due to the human inability to instantly recognize signs and take subsequent action. This neglect equates to approximately 67% of children diagnosed with ASD (determined in a JCPP study) being classified as late-diagnose cases, significantly delaying imperative intervention services and therefore the child's development. I propose computer vision-based algorithms to examine every child for ASD to recognize autism in children at an early age and minimize developmental delays. The most significant cues of ASD are observed through the detection of facial expressions, particularly eye contact. In the proposed model, the algorithm examines images/videos (per frame) of children to detect facial keypoints and the Euler angles associated with them. Each frame contributes to a ratio, which at the conclusion of the analysis, generates a score in correlation with color-coded indicators of red and green to denote the absence or presence of autism signals, respectively. Medical practitioners should then carry out a full ASD examination if indicated by the model. In computational experiments, I found the computer-vision-based neural network model to have a success rate greater than 90% in correctly indicating ASD in children in both medical and virtual settings, suggesting that a robust recommender system to detect early signs of Autism is feasible by facial expression analysis.

SCM118: Properties of Trajectoids

Please visit student's exhibit for abstract

SCM119: Reducing Bias Against Minorities in an Artificially Intelligent Skin Disease Detector Using Stable Diffusion

This project addresses the ethical implications of using artificially intelligent neural networks in medical diagnosis, with a focus on skin diseases. While artificial neural networks have demonstrated high accuracy in diagnostic applications, they have been found to learn biases against minority populations due to imbalanced training datasets. This study aims to investigate the impact of artificially balancing such datasets on the fairness of an AI skin disease detector, specifically in diagnosing individuals with underrepresented skin tones. Using the Fitzpatrick 17K dataset, synthetic images resembling darker skin tones will be generated and added to the original dataset. Two neural networks, one trained on the imbalanced dataset (control) and the other on the artificially balanced dataset (proposed), will be implemented and compared to determine if artificially balancing training datasets improves the fairness of diagnostic networks.

SCM120: Using Machine Learning Models to Predict AIzheimer's Disease

The purpose of this experiment is to determine the efficacy of machine learning on predicting Alzhiemer's disease based on patient medical data and MRI brain scan features. Early detection of Alzhiemer's disease has been persistently difficult and a time consuming process for doctors, as the disease prolongs it becomes easier to detect. Previous data has used MRI scans, biomarkers and numerical data to research the disease. Artificial Intelligence is beneficial as it has the ability to create models more efficiently, and can detect complex data patterns. The goal of this experiment is to learn how to create predictions using machine learning models and determine which model produces the highest accuracy and robust results between Logistic Regression, XGBoost Classifiers and Decision Tree Classifiers.The methodology begins with choosing a reliable data source to collect public data from, the data being used is from Kaggle and it is OASIS 2 Cross Sectional from Washu it contains 373 data samples. Once the data is chosen it must be analyzed and repaired to make sure there are no missing values. Next the data can be split into Test and Train groups, these groups are then used to train the classifiers and test them on the test data. There are nine independent variables or inputs which include: Visits, MR Delay, Age, EDUC, SES, MMSE, ASF, eTIV, and nWBV. The dependent variable or the outcome variable has two potential outcomes: Demented and Nondemented. These will be represented numerically by its CDR- Clinical Dementia Rating. After the models run and predict its results to ensure it is producing the most accurate and robust results it is necessary to then run performance evaluations. Leave One Out Cross Validation produces the most robust results because it tests each data sample in a loop where the train will be 372 and the test will be 1 data sample at a time. Once one out cross validation is run, the accuracy for each of the models is determined and a confusion matrix is shown which shows the true and false positives and negatives for each of the models. The hypothesis states that XGBoost will produce results with the highest accuracy because the other two models are single classifiers while XGBoost is a Gradient Boosted Classifier that uses multiple trees to ensure the least amount of errors therefore it should produce the most accurate results.

SCM121: Study Buddy: Revolutionizing Learning for Students Using Artificial Intelligence

Please visit student's exhibit for abstract

SCM122: Machine Learning and Water Potability

A major a issue that affects many is a lack of access to clean water. Water testing methods can help in identifying clean sources of drinking water. However, many of these methods require time to produce results that can sometimes be inaccurate. Machine learning can play a role in water testing, given its potential to produce immediate and accurate results. The objective of this experiment is to determine the accuracy different machine learning algorithms in analyzing water potability. This will be done through creating machine algorithms based on a dataset containing data on water potability, and then testing the accuracy of each model in analyzing different data from the same dataset.

SCM123: A sensitivity analysis-driven approach identifies treatment targets in GBM stem cells

Sensitivity analysis is a computational approach used to quantify the susceptibility of a system and its individual elements to internal or external changes. The purpose of sensitivity analysis is to aid in helping locate critical regulatory pathways in the system and to give insights into the responsiveness to interventions or treatments. Our hypothesis is that sensitivity analysis, when conducted under dynamic conditions, yields more accurate predictions of influences, and identifies the most effective interventions. To test this hypothesis, we chose to analyze the sensitivities in the model of the intracellular network of glioblastoma multiforme (GBM) stem cells. We identified the set of key parameters within the sensitivity analysis tool and designed a systematic procedure to investigate the impact of different parameter values on the sensitivity analysis outcomes. Next, we conducted computational experiments by using a Jupyter notebook through which we ran the sensitivity analysis tool and a stochastic simulator. Our experiments captured, in silico, the behavior of several GBM cell lines and identified most influential model elements, highlighting potential treatment targets. Furthermore, our data analysis approach provided researchers in systems biology with new insights into optimal practices for choosing parameter values when investigating model sensitivity.

SCM124: Usage of EEG-Based BCI System for Emotion Regulation in Autism Spectrum Disorder

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder often accompanied by impaired Emotion Regulation (ER). The Emotional Awareness and Skills Enhancement Program (EASE) is a 16-week behavioral intervention technique developed to help individuals with ASD manage their intense negative emotions, alongside their ER. An Electroencephalography (EEG) Brain-Computer Interface (BCI) system has been used to detect, process, and measure neurological data and thus be used as a tool to help better understand ER in individuals with ASD. In this study, the researcher accessed the emotion-triggered neurological data via EEG-BCI technology on 39 preselected participants using machine learning algorithms i.e. three random forest classifiers and 5-fold cross-validation techniques. The preliminary data indicates differences between the neural responses for pre-EASE and post-EASE treatment in comparison to the pre-Control and post-Control groups.

SCM125: Detecting a Medial Collateral Ligament Tear Without Medical Expertise

One of the most common injuries that occurs during physical exertions is the Medial Collateral Ligament tear. The use of a device that can possibly determine when the knee could potentially be at risk for an injury as severe as grade 2 and 3 MCL tears. This device would most likely be utilized by those without medical expertise and experience, potentially lowering the risk of further damaging the joint. With the use of the Logger Pro program, data would be accurately collected from a sample video of my own healthy knee. Then, this knowledge will be transferred over into the experimenting of using an accelerometer to detect angles that prove abnormal in the knee joint. These abnormalities will identify if a Medial Collateral Ligament tear has occurred and the patient needs to seek professional assistance.

SCM126: Exploring and Applying Audio-Based Sentiment Analysis in Music

Sentiment analysis is a continuously explored area of text processing that deals with the computational analysis of opinions, sentiments, and subjectivity of text. However, this idea is not limited to text and speech, in fact, it could be applied to other modalities. In reality, humans do not express themselves in text as deeply as they do in music. The ability of a computational model to interpret musical emotions is largely unexplored and could have implications and uses in therapy and musical queuing. In this paper, two individual tasks are addressed. This study seeks to (1) predict the emotion of a musical clip over time and (2) determine the next emotion value after the music in a time series to ensure seamless transitions. Utilizing data from the Emotions in Music Database, which contains clips of songs selected from the Free Music Archive annotated with levels of valence and arousal as reported on Russel's circumplex model of affect by multiple volunteers, models are trained for both tasks. Overall, the performance of these models reflected that they were able to perform the tasks they were designed for effectively and accurately.

SCM127: Easy Flashcards

The reason for creating this project is to provide students with an easy way to study using flashcards and to learn how to use a modern and relevant coding language for the current environment. The goal is to make a program that would eliminate the worries of many people about servers falling or the program being inaccessible. It will use the .NET framework, coding in the languages C# and xaml using the Model view viewmodel coding style inside of the visual studio, Integrated Development Environment. The visual studio .NET multi-platform app ui template allows the user to use the application on any device including mobile devices. Web applications like Quizlet sometimes do not work due to servers being shut down or suspended for maintenance, so the goal was to create a program that people can use on any of their devices without having any worries. The application itself is a simple design of an action bar on the left hand side and the interactable flashcards on the right.

SCM128: When Whales Had Legs: Modeling Whale Evolution

For whales, their evolution from land to sea is very unique. It is hard to imagine how a dog sized land animal can change into the largest creature living in the ocean. By using fossils and other technology, scientists have pieced together an understanding of how these animals have evolved. However, no one was actually present to witness the evolution of animals. To better understand this amazing process, I developed a simple model to simulate how random mutations and natural selection can shape the evolution of a creature. The model is also a demonstration of how genetic algorithms work. By setting predetermined values such as initial population, initial size, mutation rate and total amount of resources, the program can be manipulated in many ways to show the impact of each factor. The data from the program shows the relationship between the size, mutations, and natural selection processes that drive the evolution of a whale. Additionally, the data also shows how the environment can affect the population of a species.

SCM129: Logistic Regression Versus Reinforcement Learning in Stock Trading

There is a growing concern with the use of AI in finance. Thus, a field was created to research how AI and machine learning could prove beneficial to gaining profits. This project specifically focuses on comparing two different models in stock trading: one very complex, and the other very simple. While at first glance it may seem that the complicated model has an edge over the simple one, this was not the case. In most scenarios, not all, the simple one had better predictions and ended up with less loss or more profits. This could be due to the complex model's in-depth algorithms. It may find connections between things that have none. On the other hand, the simple model focuses more on trends and statistics. Despite their precision, the accuracy for both models may be skewed: The models were trained on data that wasn't specifically examined; some aspects may not operate as intended as I am new to the field; the data only includes closing pricing, and as a trader, it would be very difficult to make a profitable trade. As a whole, this project has shown that one model may be more beneficial than another if it is implemented properly. Some aspects, including better code design, expanded data including consumer sentiment or other beneficial stock trading instruments, and a larger data source could prove to increase accuracy and overall profits for both models.

SCM130: Aging Easily

Dementia is a developed disease affecting cognition, memory, and reasoning. Recommended care for patients encourages making everyday tasks fun and structure. Technology is an effective facilitator of this care, especially for early-onset dementia patients. Leveraging technology to keep patients connected and in control, I created an emendable website Aging Easily. Serving a user-friendly interface with calming green and blue colors, the website includes features to track mood, a calendar, to-do lists, music, maps, and a way to manage contacts and care-providers. I developed this on the Chromebook text editor ‘Caret' in order to support those grappling with early-stage dementia.

SCM131: A Machine Learning Approach for the Early Diagnosis of ALS

Amyotrophic Lateral Sclerosis (ALS) is a neurodegenerative disease, with a mean life expectancy of two to five years after diagnosis. The 6-18 month average diagnostic delay from symptom onset could be crucial in determining the lifespan of patients. As of now, there is no definitive test for ALS. However, novel research has shown that speech may be an effective biomarker for ALS with dysarthria occurring in over 80% of early patients. The objective of this project was to build a machine learning (ML) model to recognize dysarthria to assist with the early diagnosis of ALS. Over 8,000 audio files from The TORGO Database of Dysarthric Articulation have been used to train ML models including decision tree, random forest, and support vector machine, with the most notable model being XGBoost, achieving an impressive accuracy score over 99%. Furthermore, the ongoing training of a convolutional neural network (CNN) on the audio data demonstrates even more promising results with a current accuracy score over 99.3%. Overall, the results of this project are promising in facilitating ALS diagnosis and have the potential to revolutionalize the way medical diagnosis is approached in the future.

SCM132: Neural Networking and Bird Species Identification in Białowieża, Poland

Please visit student's exhibit for abstract

SCM133: Mathematical Modeling for Breast Cancer Analysis and Machine Learning-Based Classification

This project will be analyzing the Breast Cancer Wisconsin (Diagnostic) Data Set through mathematical modeling and machine learning. The project will be focusing on analyzing how to classify tumors as benign or malignant. Several traits of the tumor will be considered in the analysis. The traits are the radius, texture, perimeter, area, smoothness, and concavity of the tumor. Python will be used to conduct data analysis as well as mathematical modeling. Machine learning will be implemented to conduct basic classification.

SCM134: To ChatGPT or Not? A Method for Resolving Contradictions in T Cell Knowledge

The biomedical community's collective understanding of how chemicals, genes and phenotypes interact is distributed across the text of over 20 million research articles and a growing number of network databases. While the collected information offers insights into the mechanisms behind the phenomena such as drug response variations across individuals, the issues of inconsistencies in reporting, lack of context, and advancements in technology have led to a widespread problem of conflicting or paradoxical findings and claims. Can we determine which AI-driven approach is most suitable for identifying and resolving contradictions in existing knowledge to effectively guide CAR T cell design? Our hypothesis is that a methodology that combines both large language model (LLM)-based and natural language processing (NLP) methods offers the most effective approach to handle contradictions in knowledge sources. To support our hypothesis, we identified a baseline T cell model that guided our literature search. Next, we created search queries to collect literature for processing with NLP tools and designed a procedure for prompting ChatGPT. We explored methods that could be used to identify and resolve contradictions in collected T cell information. Our novel methodology suggested useful steps when resolving contradictions and evaluated the utility of ChatGPT in this process.

SCM135: Using Machine Learning to Analyze B Cell State Change

In this project, I used single-cell multi-omic data (scRNAseq and scATACseq) from B cells to construct a gene regulatory network (GRN) for simulating transcription factor (TF) perturbations. Through computational TF knockout using the CellOracle program, I clarified the impact of perturbations on gene expression and B cell state change between a variety of already known states, such as naive, activated, pre-GC and plasmablast. I was able to produce results that aligned with previously known key genes in the B Cell gene regulatory network, and suggested other important genes for perturbation. Future work entails experimental validation of these perturbations through knockout experiments.

SCM136: Culturally Expansive AI Music Recommender System

Many music sites use collaborative filtering: they recommend music based on what similar users have streamed. My AI introduces new music to listeners based on features of the pieces they have liked. The AI creates a more personalized and deeper understanding of the users' music tastes. This benefits society by enabling individuals to discover new musical pieces and genres they will like - thereby enriching their lives. Also, if desired, my system is able to recommend songs that the user is likely to enjoy, which were produced geographically far from the user, fostering an opportunity to enjoy music of new cultures and broaden the user's horizons. Thereby users become more open-minded and respectful towards new music and cultures they previously may not have considered. I created a system using data from the Million Song Dataset, which includes musical features such as key, tempo, energy, year, and many more. I built a deep learning system that predicts, based on the features, whether the user will like the song. To do this, a user rates some songs, and based on that data, my AI learns to predict what types of music the users likes. Finally, it generates personalized recommendations. This contributes novelty to the users' song choices and disseminates culturally diverse music. My experimental results show that the AI learns to generalize: its predicted ratings for a user of pieces that the user has not heard before are significantly more accurate than simply giving those pieces a rating equal to the user's average rating.

SCM137: Invasive Species Neural Network Recognition

The purpose of this experiment is to fine-tune a PyTorch model to find Spotted Lanternflies in images. The procedures to do this will be assembling the datasets using Google Image Search, annotating the images, changing those annotations to masks with maskGen.py, and running the model using the test and training datasets. The end result of this was an F1 Score which showed the effectiveness of the model. The model can be used in conjunction with security camera footage to quickly and easily find where spotted lanternflies have spread to.

SCM138: DNA Classification Model

Please visit student's exhibit for abstract

SCM139: Quantum Computing and Hydroelectricity?

My project is a combination of quantum computing and understanding concepts of water, and hydroelectricity. I'm trying to use a quantum simulator and find information about water molecules. And use the information I have obtained to have a deeper understanding of hydroelectricity, and water characteristics. My goal for this project is to understand water molecules, and hydroelectricity better at the end. I'm going to simulate water molecules in a quantum simulator, using IBM's quantum platform, coding the simulation with Qiskit. Qiskit is a type of code that is specifically used for quantum computing. I'm in the midst of learning Qiskit and trying to simulate water molecules. Furthermore, I will then graph all the results/data I have obtained from the quantum simulator. Then will analyze the graphs, and look for patterns, and then study more about hydroelectricity. Then I will tie my data and results I have obtained from the quantum simulator into hydroelectricity. This is my plan for this project this year, I'm currently working through the plan. I'm still simulating water molecules on the quantum simulator, so I don't have results/data currently. So, data/results and conclusions will be given at a further date of time when I have completed my research.

SCM300: CardioGuardian: An Novel Electrocardiogram Based AI Diagnostic Pathway for Early Detection of Contributory Factors to Sudden Cardiac Arrest

Sudden Cardiac Arrest (SCA) is the leading cause of death among athletes of all age levels in the United States. Current methods of pre-screening for contributory disorders are ineffective, and implementation of the International Olympic Committee's recommendation for 12-lead Electrocardiography (ECG) screening is prohibitively expensive in the United States. By combining recent advances in artificial intelligence along with ECG-based screening, we propose a preliminary comprehensive screening system (CSS), CardioGuardian, to efficiently and economically screen large populations for contributory disorders to SCA. The CSS hardware was composed of a novel smartwatch-based methodology, recording a sequential 4-lead ECG. The CSS software consists of two components: a cubic spline-based upscaling algorithm that upscales 4-lead ECG signals into 12-lead signals, and a novel deep-learning classification model, TAES (Transformer Auto-Encoder System), that utilizes the transformed 12-lead data to identify cases with contributory disorders. We trained on a clinically verified 12 lead ECG database comprising ECG files from 43,231 individuals to develop and evaluate both algorithms. The classification algorithm achieved macro F1 of 0.95 and micro F1 of 0.97 on the testing dataset using spliced 4 lead ECGs as training data. Human subject trials were conducted with healthy controls using the smartwatch methodology with our algorithm resulting in 0 misidentifications demonstrating baseline viability. We propose an economically viable protocol CSS demonstrates superior accuracy on large-scale population screening, highlighting the need to replace outdated systems. Our future work focuses on clinical implementation and further software development.

Engineering / Robotics (SER)

SER100: Development of a Low Cost 3D Printed Violin

Although participation in middle and high school music ensemble groups is associated with higher graduation rates, lower substance use, and higher math proficiency, only 36% of high schools with music programs have a string orchestra. For low-income schools, the high cost of instruments can be a barrier to developing orchestra programs and teaching children how to play instruments. To solve this problem, I designed a violin that can be manufactured on a low-cost 3D printer. My engineering goals were to make it mostly 3D printable, easy for anyone to print and assemble, and cost less than $100. Using measurements from a 1716 Stradivarius violin as a guide, I used computer-aided design (CAD) to design a full size violin that can be printed in 3 main parts and assembled easily. The printed violin was playable and produced good sound quality. The CAD file can be released on an open source 3D printing site for anyone to access and is a practical solution to making violins more accessible to students in low income schools.

SER101: An Automated Robot to Assist in Material Handling and Putaway to Reduce Human Error and Inconveniences

A problem that ranges within all companies and stores is Inbound Logistics: the method of transporting materials and goods inside a company. Human error embodies a large portion of this problem as ~80% of material handling and putaway errors are pursued by humans, resulting in an overall loss of money. The engineering goal of my project is to design, develop, and program a working robot that is capable of autonomously moving to specific locations until detecting a designated April Tag, collecting the designated material(s), and unloading the materials collected. I strived to achieve these tasks autonomously with over 75% accuracy. My general procedure encased three major processes: the design process, manufacturing process, and software development process. The design process included brainstorming the robot's functionality and using CAD to design an efficient robot. The manufacturing process utilized cutting custom parts on a laser cutter and assembling the robot with the power system. The software development portion in Java consisted of the conjoined program of the motion-profile tuning, OpenCV April Tag detection process, and subsystem software. I tested this autonomous program 30 times with the same type of objects and a varying number of objects to be collected. My results were successful as the accuracy rate exceeded 75%. Upon data analysis, the number of objects the robot needed to pick up was inversely proportional to the success rate. This instigated the conclusion that material handling and putaway are solvable by an autonomous robot, but several design considerations and inputs are necessary.

SER102: Time Perception Based on Music Tempo

This behavior study aims to find a correlation between music tempo and perception of time passage. Participants assess the duration of classical era piano compositions set at varying tempos. To minimize the impact of confounding variables, the experiment, to the best of material availability, aims to create a controlled environment through the implementation of equal sound quality, listening environment, and piece duration, focusing on only changing tempo between each trial. It is hypothesized that as the tempo of pieces increased, the corresponding perception of time would be faster. Data collection is done through the Google applications of Forms and Sheets. At this point in the experimentation, no significant conclusion can be drawn. This study also explores the connection between knowledge of music, familiarity, and favorability towards a piece to the perception of time passage. This interlude contributes to the practical application of the conclusion of this study. The data of this study can help determine situations where faster or slower tempos should be used in order to convey a sense of faster or slower passage of time, respectively. This can be used in settings of advertisement and public spaces such as fast food restaurants, which feature faster paced environments, which contrast with waiting rooms, which need the sense of slower time passage.

SER103: An Electrolytic Approach to Sustainable Water Treatment in Developing Countries

The global water crisis, causing 3.5 million annual deaths, is one of the most pressing humanitarian issues of modern times. These challenges are primarily seen in developing nations, where rapid population growth drives urbanization, and the growth of urban regions outpaces the development of sanitation infrastructure, leading to bacteriological contamination of surface waters and groundwaters. From this contamination, waterborne illness has emerged as the leading cause of death for children under 5 years of age. These issues drive the need for low-cost, sustainable water treatment that is capable of treating microbial water contamination in developing urban regions. After a review of 20 different treatment technologies, a process utilizing electrocoagulation, slow sand filtration, and electrochlorination was selected and developed to provide such treatment. This novel approach would provide adequate bacteriological treatment coupled with the removal of additional chemical contaminants without the use of hazardous chemicals, highly expensive equipment, or laborious maintenance. The treatment process is controlled through current regulation, both simplifying operations while also enabling the use of renewable energy sources (ex. solar cells) to directly control the system. Commissioning was conducted for experimental electrocoagulation and electrochlorination systems, and the results were successful. Bleach was produced to a concentration of 40 ppm, and ferric hydroxide coagulant was also produced. This study has shown promise for the success and applicability of this electrolytic-based process. Further work to quantify the rate of chemical dosage and to develop a continuous-flow prototype model is currently underway, and results will be available on fair day.

SER104: Generation of an Asymmetrical Virtual Four- Bar

In the real world, certain areas of cargo and luggage transportation task arms to rotate around 1 specific pivot point, to allow the end effector to reach different positions or possibly the highest position. However, consequences arise as a regular fixed connection between the end effector and the arm force the end effector rotate proportionately to the arm in the same direction as the arm, and thus the cargo and luggage are no longer in a safe orientation to be transported in. My further discoveries led me to the virtual 4 bar, an arm utilizing a chained connection between 2 identical sprockets to keep the end effector in the same orientation all throughout the arm's travel. However, a virtual 4 with differing size sprockets creates an Asymmetrical Virtual 4 bar, where the end effector's orientation constantly changes as the arm travels. Through several iterations, my experiment studied the rotational direction of the components and the effect of the sprocket's sizes to ultimately create a formula, which users can use to create their own fully customizable asymmetrical virtual 4 bar.

SER105: Predicting the Presence of Common Mold on Bread Before It Appears Visually Using a Naive Bayes Classifier

Mold is a common fungi that grows on various different foods, such as breads, fruits, vegetables, and cheeses. Mold species that grow on bread such as Penicillium chrysogenum are considered one of the four most allergenic fungi and have been linked to asthma development. Global sensitization rates for Penicillium range from 400 to 600 million people, meaning there have been at least 400 million people exposed to this mold before. This project used environmental and pH sensors to develop a machine learning model that can predict whether mold has grown or not before its visual appearance to help alert consumers when their bread is about to expire. 12 slices of bread were split into 4 pieces each, for both training and testing data. Two pieces of bread were stored per Ziploc bag for about nine days. The environment inside the bag and the pH of the bread were measured once at the beginning of the project, once about midway through, and once after nine days. The start and stop data was put into a Na‹ve Bayes classifier and tested using the second set of data collected. The data for the humidity, pressure, gas volatility, and pH show a clear rise in values after the mold has grown. The machine learning model's accuracy was about 72% from about 1102 total data points. A one sample confidence interval analysis projects the model's accuracy to between 69% and 74% when used in the real world.

SER106: The Impact of Winglet Design on Air Resistance

This study investigates the impact of cant angle variations on aircraft drag through wind tunnel experiments, aiming to address the question: How do variations in cant angle on winglets impact drag on an aircraft? Testing at speeds of 11 m/s and 15 m/s, with cant angles set at 40º, 50º, and 60º, I measured drag levels as the wing traversed the wind tunnel. Results unveiled a significant reduction in drag at a 50-degree cant angle compared to 40 and 60 degrees, suggesting the potential optimization of winglet design. This observed drag reduction indicates the importance of further research to validate and refine these findings. The outcomes highlight that a 50-degree cant angle minimizes wingtip vortices, correlating with decreased drag during flight. In conclusion, my study provides crucial insights into the aerodynamic effects of cant angle variations on aircraft drag. Careful consideration of cant angles, particularly at 50 degrees, holds promise for enhancing winglet design efficiency, contributing to improved flight performance and fuel efficiency. Further investigations are warranted to validate and extend these results, deepening our understanding of optimal cant angles in aerodynamics.

SER107: Far Field WPT

Most sources of transportation for energy/electricity is through the use of physical materials like power lines or cables many over a long distance. These long distance transmissions require power lines, and if these lines are damaged or broken, can lead blackouts, or deaths and injuries by contact with downed lines. The purpose of this project is to make an attempt to replace wired energy transportation with wireless transmission. This idea is inspired by the United States Air Force Research Laboratory's, SSPIDR (Space Solar Power Incremental Demonstrations and Research Project), and will put it into a perspective meant for global civilian usage. A model will be created to intake solar power via solar cell into a transmitter that will transmit 2.4GHz across a distance to be received and converted back into electricity. Raw electrical output from a solar cell will be measured, then output from the model will be measured, both by a multimeter. The measurements will then be compared and analyzed to find the difference and power loss amount. The prediction is that there won't be significant amounts of power loss. I will also try to account for factors of distance, physical interference, and possibly other types of waves (e.g. higher frequency radio waves) that will interfere with the transmission in order to produce the best results possible.

SER108: Using Acceleration and Jerk to Examine LSM's

Roller coasters are one of America's favorite pastimes. Roller coasters are the ultimate example of energy conservation. One of the ways they initially gain energy is through a launch. Of the many types of launches LSM, or linear synchronous motors, are the favorite choice. The project will attempt to recreate an lSM to see if the acceleration experienced by a roller coaster is constant. The first part of the press is to build the track. Next put electromagnets on top of the track and finally 3D print a cart to be accelerated. Using a motion sensor final kinematics will be used to determine if the acceleration is constant. There is no data at this point to determine that. If the acceleration is constant or near constant the technology could be used in other fields to help with efficiency.

SER109: Developing an Autonomous Robot for Litter Collection

Litter is a major problem across the United States and around the world. There are over 23.7 billion pieces of litter along roadways in the United States alone, where collecting litter can be dangerous due to the vehicles traveling at high speeds nearby. Floating autonomous robots have been utilized to collect trash in waterways and robots have been used in homes for years to vacuum, so could autonomous robots be developed to collect litter along highways as well? In this project I worked to develop an autonomous robot for collecting litter in public spaces, specifically the sides of freeways. I constructed the frame and mechanical systems for the robot first, consisting of a large (32"x22"x18") aluminum chassis with two 12-inch drive wheels, as well as a custom 5 DOF robotic arm installed on the front to collect litter. The chassis includes a number of sensors to determine the orientation and speed of the robot, as well as a camera to look for litter. I then developed software for the robot, including programs to navigate the robot along a specified path, to operate the arm, and to run a custom computer-vision model to identify litter. All of these independent systems then had to be integrated to create one complete system that allows the robot to drive along a path while collecting any litter it comes across with 88% accuracy. This project is an important step towards automating litter collection and keeping streets indefinitely clean without the risks to humans.

SER110: Moisture Degradation of Perovskite Solar Cells

With traditional silicon solar cells being the lead on the market for the past almost 75 years, as energy consumption is increasing, they are not capable of catering to this demand. Perovskite solar cells, CH3NH3PbI3 or methylammonium lead iodide, have shown they have the efficiencies to do so. Yet, they are not commercially available because they only have the stability to last several months to a year. This is due to moisture degradation of the crystal as water forms a hydrogen bond with the methylammonium cation. However, a hygroscopic desiccant such as silica gel, which is very porous, has the ability to remove such moisture and prevent it from decaying the cell. By doing so it will increase its longevity, making it a viable option for the market.

SER111: Designing a Glucagon Syringe

For my project, I reverse engineered an insulin syringe and adapted it to measure glucagon. People who have type 1 diabetes do not have a functioning pancreas, and therefore, have no method of insulin or glucagon production. While there are many different systems of insulin delivery, there are not as many for delivering glucagon. At this point in time, all public methods of administering glucagon are for emergency use only. In order to design a syringe to administer glucagon in small enough doses to be used in non-emergency situations, I redesigned an insulin syringe via reverse engineering and modified the markings to indicate the appropriate amounts of glucagon. I also added small holes in the needle and syringe caps because I noticed the insulin syringes did not have them, which is a potential choking hazard. So far, I have designed a prototype that I would like to 3D print and further redesign in the future.

SER112: Engineering Limb Movement Tracking System for Medical Diagnosis and Treatment

The Rise of medical joint and limb related issues, and the rising costs of medical diagnosis or treatment has made it hard for people to be able to afford or find medical diagnosis centers. Due to this, I created a low cost easily purchasable diagnostic tool for use in medical diagnosis of various conditions. The technology I am using to do this is the limb movement tracking system (LMTS) that I created to track the angles of individual joints at high precision to give data to a medical professional on the patient's mobility. The cost of medical diagnosis tools that are being used in physical therapy and other medical fields relating to the topic cost from $300 to as high as $1,500. As my system can be produced for less than 50 dollars with off the shelf components and some basic tools it will be a more viable solution for patients who may not be able to visit the hospital but still need diagnosis as the device can be used by an individual at home to automatically gather data to send to a medical professional over the internet. The LMTS Uses a microcontroller called an ESP-32 to send the tracking data over wifi to a computer or phone to log data in txt file format for a medical professional to use. The way I tested my device was by testing the precision of each mechanical tracker on a fixed test setup that would allow me to check if the device had correctly measured real angle it was at/ of the theoretical joint it was tracking.

SER113: Constructing a Hydrogen Battery by Means of Pressurized Alkaline Electrolysis and a Fuel Cell

A major problem with renewables is their intermittency in energy production. Energy storage is a great way to solve this. Hydrogen is a potential solution, so I focused my project on hydrogen energy storage. My engineering project goal was to build a device that would produce hydrogen utilizing electrolysis and pressurize the hydrogen in a tank. When the stored energy was wanted, the hydrogen could run through a fuel cell, generating electricity to charge electronic devices. I decided to use the force of the electrolysis itself to pressurize the hydrogen, bypassing the need for an air pump. I built the device using a fuel cell/electrolysis membrane, a plastic bottle, and various electrical components. Once built, I was able to charge it through any outlet, and after enough hydrogen was produced, I could plug in a phone and the fuel cell charged the phone. I performed tests to find the energy density and efficiency of the system. With a pressure of 10 bar, the system could store 58.6 kilojoules of energy, but due to inefficiencies in the fuel cell and electronics, only 14.4 kilojoules of this energy were recoverable. Given the size of the tank, it had low energy density. However, many future improvements could be made to the system that would allow it to surpass the energy densities of lithium batteries. By using a tank that could hold higher pressures combined with more efficient parts, the same-sized system could store up to 1660 kJ of usable.

SER114: Water powered engine based off the scientific process of electrolisis

This study dive into the development of an electrolysis-based engine, a system harnessing electrochemical processes for energy conversion. Through the utilization of electrolytes(salts) and materials, the engine aims to enhance efficiency in converting electrical energy into chemical energy, therefore creating a combustible fuel. The research contains comprehensive design, optimization, and efficiently. Thereby potentially revolutionizing the engine industry.

SER115: Which Shape of Infill is Strongest for Constriction when 3D Printing

Please visit student's exhibit for abstract

SER116: Beyond Adhesives: Unlocking the Potential of Japanese Wood Joinery in Balsa Wood Structures

This project sought to find an effective method of including Japanese wood joinery in the construction of balsa wood structures by building and crushing different models with or without adhesives. The initial hypothesis was that the structure assembled with glue would hold more weight than the one without because glue can keep the structure from shifting while being crushed, thereby maintaining an equal weight distribution. The method used in each structure follows a similar pattern, with each structure having the same design excluding the joints. In a glued structure, the joints are connected with glue without extra pieces; however, in a non-glued structure, there are additional pieces acting as pins or frames to keep the structure together. These are added where glue would have typically been placed. During the initial experiment with empty frames, the structure that would have been entirely without glue managed to keep its sides together individually. However, difficulties were encountered when attempting to connect the sides, ultimately leading to the total collapse of the structure before weights could be tested. To remedy this, the side braces were glued, but the sides were attached with wood joinery techniques. This held together, but was crushed almost completely while showing signs of unequal weight distribution with its spinning. The glued structure held 45 pounds, but it also eventually collapsed while spinning slower than the partially glued structure. With the continued experimentation of different design types utilizing trusses, further information can be used to justify the extent to which wood joinery should be used in balsa structures by the competition.

SER117: Development of an Auxetic Artificial Heart

The field of auxetics has much potential and can apply to many fields including the design of pumps. By applying auxetic pumps in the field of artificial hearts, which has remained mostly stagnant, a new type of artificial heart can be created which is just as effective but much cheaper to produce and can be much more easily optimized for an individual. This paper will define the design process for an auxetic diaphragm pump. This definition will then be applied to design a pump that can replicate the function of the human heart. This project will use a 3d printer with flexible filament to print auxetic structures. These structures will then be used in pumps and tested by pumping water. The flow rate of the pump will be measured. The results of the test will be compared with the parameters on the original structure. By doing this an outline for designing auxetic diaphragm pumps will be calculated. This outline will be applied to produce a pump with the same capabilities of the human heart.

SER118: Strength of bioplastics

Please visit student's exhibit for abstract

SER119: Off-Grid Aquaculture System for Rural Africa

This project addresses the pressing challenge of revitalizing flooded, abandoned mines in Sierra Leone through an innovative engineering intervention. Applying mechanical engineering principles, the goal is to transform stagnant pools within these mines into thriving fish breeding ponds. Employing 3D printed scale models, solar technology, water pumps, and filtration, the off-grid aquaculture system overcomes challenges like the lack of access to electricity. The humanitarian objective is twofold: to provide a sustainable food source for local communities and enhance biodiversity in formerly inert waterways. By breeding fish like tilapia, the initiative supports local diets and creates economic opportunities through fish sales, contributing to income generation for West African communities experiencing poverty and malnourishment. The research explores how mechanical innovations restore ecosystems, offering a holistic solution for repurposed mining sites. The comprehensive project includes planning, scale model construction, energy input variability testing, data collection, analysis, and performance optimization. The anticipated outcome is a validated mechanical engineering approach addressing ecological challenges, promoting the humanitarian goal of sustainable development in Sierra Leone's mining regions.

SER120: An Empirical Evaluation of Textiles for Reusable Menstrual Pads

Recent advances in textiles have made reusable fabric menstrual pads a viable substitute for disposable menstrual pads, but little has been published on reusable pad effectiveness. In this project I evaluated the wicking, absorption, and waterproofing abilities of different types of textiles to find a combination well-suited for a reusable multi-layer menstrual pad. In previous work, I tested 17 fabrics and two reusable pads I constructed. My reusable pads had similar absorption and waterproofing properties as a disposable pad control but were worse at wicking. This year using the wicking test procedure from previous experiments, I tested four more wicking fabrics against two previous front runners. Using the top two fabrics from this test, I composed two reusable pads with a wicking layer, two absorption layers, and a waterproofing layer to test against three commercial reusable pads and a disposable pad. Two commercial pads performed better at wicking and absorption than the pads I constructed. I then performed wicking and absorption tests on swatches of the wicking and absorption layers from my pads and the two top commercial pads. The fabrics from my pads performed better than the fabric from commercial pads, even though the composed pads performed worse. When I repeated the wicking test using the more realistic UNICEF protocol, the advantage of the commercial pads shrank. In addition, my pads and the top two commercial pads all outperformed the disposable pad.

SER121: Portable Technology to Monitor the Health of Waterways

Water quality monitoring is crucial for preserving the health of aquatic ecosystems. This study addresses the impact of environmental factors such as climate change and pollution on water quality and its implications for marine life. We propose a portable sensor package designed for crowd-sourced data collection to assess the health of waterways. The package includes temperature, conductivity, and dissolved oxygen sensors, which are vital indicators of water quality. By deploying these sensors on kayaks and other watercraft, we aim to gather comprehensive data across various locations, facilitating informed decision-making by authorities responsible for water management. Our methodology involves data collection along different points of the Allegheny River, enabling comparative analysis with historical data to evaluate water quality trends. This initiative offers a practical approach to monitor and mitigate the adverse effects of environmental stressors on aquatic ecosystems, thereby safeguarding the well-being of marine life and promoting sustainable water management practices.

SER122: Trekking Pole Generator

While hiking out in nature, the batteries of small devices like cell phones will drain and eventually die. When spending large amounts of time in nature, it becomes suboptimal to charge a portable battery to use prior to taking a trip. This research aims to engineer a trekking pole generator that has the ability to harvest energy from the strikes of a trekking pole on the ground as it is used for its primary purpose. This project will use the concept of a motional electromotive force (emf) generator as a part of a trekking pole to generate a potential difference, similar to the currently available shake flashlights. When arranging a pair of rare earth magnets inside of a tube with the same poles facing each other, mechanical energy may be stored and released similar to the elastic potential energy in a spring causing the magnet to rise and fall inside of the coil-wrapped tube. This project will seek to establish if the use of trekking poles in different scenarios will generate enough mechanical energy to cause a motional emf in sufficient quantity to be useable as a low-cost, lightweight, robust generator. The poles will be used at several speeds and inclines to determine the viability of such a generator as a means of charging small devices while without access to a power grid.

SER300: The development of low-cost solar-lunar panels to harvest electricity at night and increase efficiency of solar panels using thermoelectric generators

The purpose of this project was to develop a system that produces electricity at night and improve the efficiency of solar energy. First, a large fraction of the world lacks access to electricity. The absence of electricity at night poses dangerous challenges in regions without reliable energy sources. Secondly, solar panels lose valuable energy efficiency in the form of heat. Thermoelectric generators (TEGs) have the potential to address both challenges. TEGs produce electricity when exposed to a temperature difference between a heat source and a cold side. A solar panel was placed on a black aluminum plate and put inside an insulated box. The hot side of the TEG was placed under the plate, and a heat sink was placed under the cold side of the TEG. During the day, the aluminum plate transfers heat from sunlight and transfers it to the TEG. The heated aluminum plate becomes the heat source and the heat sink cooled by surrounding ambient air becomes the cold side, producing electricity. During the night, the TEG is flipped to place the cold side of the TEG under the aluminum plate. Through a process called radiative cooling, when materials are exposed to the night sky, they lose heat quicker than their surroundings. When the aluminum plate is exposed to the night sky, it causes the cold side of the TEG to lose temperature. The surrounding ambient air then becomes the heat source, producing electricity. The effect of the insulated box and different surface areas of the TEG on electricity production were tested. Temperature differences and electricity production were monitored using thermocouples and voltmeters. All materials used can be bought off-the-shelf, and the cost of the system can be made as low as $58.89. The conclusions of this project, which will be available on fair day, can provide proof of concept of a continuous energy production system that can benefit off-grid and marginalized communities especially.

SER301: Lantern Fly Egg-Removing Robot

Our project's purpose is to help our community out and get rid of the invasive species around our town. During the end of summer, our friends would scream as swarms attacked the boba shop near our house - motivating us to help our bug-scared friend out. Our materials are as follows: bars, screws, disinfectant alcohol, phones, batteries, plastic case, camera and an expansion hub. Our procedures are as follows: 1) use an AI program to teach it how to recognize lanternfly eggs on trees. 2) Make a tall and extendable robot arm to reach varying tree heights. This includes a mechanical scraping tool required for the removal of the eggs. 3) The eggs will then be collected in rubbing alcohol due to their ability to hatch even when on the ground. The rubbing alcohol kills the eggs. 4) Attach a camera connected to an AI system to the robot to give it commands based on image recognition. This will, essentially, help the robot recognize the eggs that are on the trees and will command it to, ultimately, scrape the eggs off. A camera used to film will also be attached to the robot in order to observe and collect data during experimentation. 5) Using the data collected from trials, this will track the amount of trees helped and use that information to reach a conclusion about the effectiveness and ability of the robot arm. We were able to successfully perform this experiment and the robot was able to kill many eggs around our town. Sometimes, the image recognition was not always accurate but for the most part, we felt that we were able to help our community out in a small way.

Earth and Environment (SEE)

SEE100: Co-planting Shrooms

Please visit student's exhibit for abstract

SEE101: Oxo-Degradable Plastics and the Ecological Effects

The project's purpose was to show the relationship between microplastics within the ocean and their effect on pH. According to a study by Romera-Castillo et al. (2023), polylactic acid, low-density polyethylene, and expanded polystyrene plastics increased the pH of seawater. This study helped support the hypothesis that oxo-degradable plastics will increase the pH of saltwater due to oxo-degradable plastics having a component of polyethylene. Oxo-degradable plastics are plastics that have an additive that reacts with oxygen which helps the products break down (Plastic Solutions Review, 2022). This study was conducted with this particular plastic to show the harm in advertising things as eco-friendly when they only have a small change to them. The experiment was conducted using three groups of seven microplastics, two microplastics, and zero microplastics per liter. The containers were placed under grow lights for a total of 48 hours to allow plastic leaching to occur. The pH was measured using a vernier sensor at the start before micro plastics were added and after 48 hours at the end of the experiment with a range of ñ0.02. An increase in pH was then calculated between the readings for each container. ANOVA test and T-Tests determined the results were not statistically significant thus does not support the hypothesis.

SEE102: Microplastics in Freshwater Ecosystems

Freshwater is vital to humans, animals, and plants but there is also a whole ecosystem that surrounds these bodies of water which have huge environmental benefits. Recently however, questions have started to arise about whether or not these ecosystems have been affected by microplastics which have plagued marine biomes. The purpose of the project is to determine whether microplastics affect water quality (metals and minerals) and Lemna minor (duckweed). To do this, four groups of water were set up containing duckweed with zero, one, three and six pieces of microplastics. The plastic was placed in the water for 17 days and then the individual water qualities were determined, specifically looking for zinc, sulfate, and pH. The duckweed were exposed to the plastic for just under forty-six hours and their masses were determined. ANOVA and T-Tests were run on the groups and showed that there was a difference in between the control group and the groups containing three and six pieces. This shows that there was an increase of zinc when microplastic was added to the water. Another experiment is going to be run to determine if the duckweed affected the results of the experiment.

SEE103: Sunscreen in the Ocean

The purpose of this project was to determine if sunscreen had a harmful effect on brine shrimp. Up to 25% of sunscreen that is put onto skin can end up in the ocean (van Genuchten, 2022). Around 14,000 tons of sunscreen ends up in waterways globally each year from water runoff and sunscreen application (Hall, 2022). According to Cinzia Corinaldesi, associate professor of ecology at the Polytechnic University of Marche in Ancona, Italy, in more shallow waters, ... sunscreen concentrations can reach relatively high levels. Studies are consistently showing that some chemicals in sunscreen may have harmful effects on marine life, including some by Corinaldesi. The independent variable was sunscreen added to a controlled ocean water environment. The hypothesis is that sunscreen would be harmful toward the brine shrimp because of chemicals such as the avobenzone and zinc oxide. The importance of this research is that if sunscreen is proven harmful to marine organisms, ways to prevent the use of sunscreen need to be found. The three groups were the control group, Coppertone sunscreen, and Sun Bum sunscreen. The active ingredient in the Coppertone sunscreen was zinc oxide , and the active ingredient in the Sun Bum sunscreen was avobenzone. The statistical analysis showed that the results did support the hypothesis. Measures need to be taken to prevent sunscreen contamination in the environment to avoid the loss of marine life.

SEE104: The Impact of Increased CO2 Exposure on Chickpea Growth

This experiment investigated the impact of increased carbon dioxide (CO2) exposure on chickpea growth, with a focus on climate change's impacts on our agricultural industry. I exposed four experimental groups to varying levels of CO2 by adding increasing numbers of CO2 tablets to their water, simulating the absorption of human-generated CO2 emissions by soil. My data collection over a 32-day period involved measuring the height of each of the plants to test for potential increases in photosynthesis rates and determining brix levels, indicative of nutrition content. The results aligned with my alternative hypothesis where increased CO2 exposure resulted in a decline in height and nutrition. Comparing the control and the most extreme experimental group, the average height in the experimental group plummeted 87.9%, with the best plant in each group exhibiting a 52.7% deduction. Average brix levels showed a 66.3% decrease, and only one plant survived in the most extreme experimental group in comparison to all four in the control. I was able to explain these results in two ways, the first being where increased CO2 prompted stomatal closure, leading to the plant unnecessarily retaining more water and limiting gas release. Secondly, the external pH fluctuations in the water and soil may have led to enzyme denaturation within the plants, due to their sensitivity to pH fluctuations in their environment. This experiment emphasizes the need for our society to address and control carbon dioxide emissions, as exceeding certain thresholds could jeopardize crop growth and, consequently, food security.

SEE105: Biodegradable Hydrogels

Approximately 70% of the water supply each year is for agricultural processes, with a about 40% loss to antiquated farming methods and evaporation. Water, an indispensable resource, extends beyond mere hydration to encompass everyday activities such as bathing, food preparation, and consumption. In light of the global challenge of water scarcity, optimizing soil moisture retention emerges as crucial for promoting efficient water usage in agricultural ecosystems. This study utilizes a diverse range of biodegradable hydrogels, each with distinct compositions, to assess their impact on soil water-holding capacity. Hydrogels, known for their water-absorbing properties, are employed to enhance soil moisture retention and mitigate water waste. Three types of hydrogels will be created: Agar, Hydroxyethyl Cellulose, and Agar + Hydroxyethyl Cellulose. The research from this project sheds light on the potential application of these hydrogels as eco-friendly soil amendments, offering a sustainable solution to water conservation in agriculture.

SEE106: Garden Safe and Aquatic Organisms

The purpose of this project is to see if a pesticide that runs off into the water could affect the mortality rate of the organisms that live within the environment. Cups were filled with water and soil, and one aquatic isopod was added per cup. Mortality rate was determined within a three-day period. The treatment group had Garden Safe's Garden Insect Killer added to the water. Within the three day period, every creature in the treated group had died within twenty-four hours, while only two of the twelve control isopods died. I had done three t-tests for each day, testing how many isopods lived or dies in each group, and the results showed that the data for all three days was significant.

SEE107: Optimizing Pervious Concrete for Both Strength and Water Permeability

Pervious or permeable concrete is a type of concrete without any sand or other fine particles, creating pores throughout the structure. These pores allow water to pass through, replenishing groundwater supply and preventing standing water on the surface, although the pores weaken the overall strength. The purpose of this experiment is to attempt to optimize permeable concrete based on aggregate size, ranging from %u215B of an inch to 1 inch, and water to cement ratio, ranging from 0.28 to 0.36. Concrete samples were made and organized in a grid, with the columns varying in aggregate size and rows varying in water to cement ratio. Each concrete sample used a 3:1 rock to cement ratio. These samples were tested on water storage, water permeability, impact strength, and freeze-thaw reaction. Water storage was measured on what percentage of its volume the sample can hold in water. Water permeability was measured with how fast the water can travel through the sample in cm/sec. Impact strength, measured in joules, was tested by dropping various weights at various heights to see how much joules were required to break the sample. Freeze-thaw resistance was tested by seeing how much rocks would come loose and break off after being submerged and frozen in water. After scaling the values for each test and adding up all the tests for the samples, « inch aggregate with a water to cement ratio between 0.34-0.36 proved to be the most effective.

SEE108: Erosion

Please visit student's exhibit for abstract

SEE109: The Effects of the Moringa Plant on Small-Scale Water Filtration Methods

More than 2 billion people across the globe do not have access to clean drinking water. A significant amount of this impact group consists of communities in developing countries. As a result, several water filtration methods have been designed by these populations with the goal of obtaining clean drinking water. Specifically, the Ceramic filter and the Biosand filter are common small-scale filtration methods. However, these methods are not fully effective at filtering water. The moringa plant and limewater are two coagulants that fuel coagulation and flocculation. Through this process, the negative charges of particles in drinking water are neutralized so that they begin to stick to other particles, creating flocs. These flocs can then be filtered out of water. The purpose of this experiment is to show how both the moringa plant and limewater can be used to enhance water filtration methods to supply clean, accessible water to communities in need. For this experiment, a Ceramic filter was created using a plastic container and ceramic beads. A Biosand filter were created by layering sand, pebbles, and rocks in a plastic container with a straw spigot. To test the control, contaminated river water was poured through each respective filter twice and then tested for cleanliness. Cleanliness was measured using tests for bacteria, turbidity, particulate matter, electroconductivity, and pH. To test the effects of moringa and limewater, water was poured through each respective filter once. Then, moringa or limewater would be added to the water and filtered through each respective filter a second time. The predicted outcome is that the moringa plant and the limewater will increase the overall cleanliness of the water. However, while limewater may be effective, it is simultaneously a chemical solution that is linked to underlying diseases. On the other hand, the moringa plant is a low-cost, natural source. Therefore, if effective, the moringa plant should be implemented into small-scale water treatment methods to create healthier, more sustainable communities.

SEE110: Freshwater Acidification: Do Plants Help?

Water is experiencing acidification because of increased pollution and carbon dioxide emissions. Water is a carbon sink, storing carbon dioxide. Plants remove carbon dioxide during photosynthesis. The question I explored is whether the presence of plants can reduce the acidification of freshwater. I predict that the pH of the water will increase if aquatic plants are present because carbon dioxide is being absorbed through the process of photosynthesis. In this experiment I obtained freshwater from Fall Run Creek and set up 4 tanks with 9.5 liters of freshwater in each. The pH was recorded in each. Java ferns were added to 3 of the 4 tanks and the pH was measured over the course of weeks to determine the effect of the plants on the water's pH.

SEE111: Replacement of tertiary stage in WWM system with graphene oxide membrane

This experiment investigates the effectiveness of a graphene oxide membrane (GOM) as a replacement for chlorine treatment in the tertiary stage of a wastewater treatment (WWT) cycle for the purpose of irrigation. The escalating global issues of climate change and urbanization have intensified wastewater discharge, necessitating sustainable solutions for water reclamation. The study aims to demonstrate the viability of utilizing GOM in the tertiary treatment, providing economic and sanitation benefits. The experiment follows a design involving a replicated WWT system, with greywater samples from two households. The primary, secondary, and tertiary stages employ various treatments, including chlorine tablets as a control and GOM. The study analyzes the treated samples for pH, water hardness, chloride, phosphorus, total dissolved solids, and salinity, comparing the results with irrigation water criteria. The rationale for the experiment stems from the potential environmental impact of wastewater discharge and the need for efficient water reuse practices. The hypothesis posits that replacing the traditional tertiary treatment with a GOM will yield more effective results for agricultural usage. Safety measures include the use of protective gear and proper disposal methods for hazardous materials. The data analysis will determine the suitability of each treatment method for irrigation, with a focus on meeting USEPA criteria. If the results align with the hypothesis, the experiment may contribute to sustainable water treatment practices, addressing the growing concerns surrounding wastewater management. The findings, presented visually, emphasize the superiority of GOM over traditional chlorine tablets in the tertiary stage of WWT for irrigation purposes.

SEE112: The Effect of Noise Pollution on the Hatching Rate of Brine Shrimp

The topic of ocean pollution usually brings to mind the image of plastics, oil spills, and sewage. However, there are somewhat invisible pollutants such as noise pollution that can be just as impactful. To simulate the effects of noise pollution on sea life, I will be creating 5 separate petri dishes with 20 brine shrimp eggs in each. Each dish will be isolated with a speaker that plays different frequencies over the course of a week. Throughout this week I will collect data on the total number of shrimp in each dish. The data collected will be used to investigate the impact of sound frequency both on brine shrimp birth rate and mortality rate. Research is still ongoing and results will be presented on fair day.

SEE113: How different plant types affect the pH of soil

Many news articles show alarming insight on plants changing the pH of soil, directly damaging soil health and nutrients. The purpose of my experiment was to test different plants and see how they would affect the pH of soil in various ways. In addition, I wanted to see how this could affect agriculture. To do so, I collected the soil and found it to be 6, so I changed the soil pH to all start with 7 by adding calcium. Then, I put soil into 30 plastic cups, including 6 of each kind of plant. I planted the 5 groups, including golden pothos, lavender, creeping fig, gold dust, and a control group of soil. Every 3 days, I watered the plants and tested the soil pH. Finally, after 8 weeks, I recorded the results and pH to compare from before. I found that the golden pathos became more basic, from 7 to 8.7. The lavender stayed around the same, with changes in between. The creeping fig became acidic, from 7 to 5.2. The gold dust became more basic, from 7 to 8.3. Finally, the control group of soil stayed the same. So, I concluded the data that all plants tested slightly changed the pH of soil by making it more acidic or basic. Because of this, the soil could be less healthy, harming the environment and plant health. So, the best solution would be to frequently check soil pH to prevent more harm, and adding neutral compost.

SEE114: Reducing Invasive Species Growth Using Household Materials

Invasive species can be difficult to handle, as they tend to overtake any areas they are in and most permanent solutions can be very costly. In order to best determine how to deal with them without spending a lot of money, household items known to be able to remove invasive species were tested in order to best calculate which will remove the plants the best. Bamboo and mint plants were propagated and repotted, which were grown in a grow chamber. The bamboo has yet to grow roots, but the mint is growing. The household solutions added to the plants will be boiling water, glyphosate spray, distilled white vinegar, 3.5% salt water, and borax; there would also be dish soap added exclusively for the mint. The solutions are being added every two days in order to ascertain what solution most effectively stops the growth of the invasive species. Data collected would be how long it takes to stop growth and the amount of plant grown. The plants are still growing, so there is no data as of yet, but most of the solutions are expected to kill the plants.

SEE115: Converting Organic Waste to Ethanol

With the global climate crisis and the increasing pollution rates, fossil fuel use has become unsustainable. This experiment aims to identify a clean, inexpensive and sustainable way to create ethanol-based biofuels from organic waste. To conduct this experiment, I gathered 7 types of organic waste; apples, banana peels, black grapes, cabbage, corn, potatoes, and tomatoes. I added the distiller's yeast and distilled water and allowed the biomass to ferment for 7 days. At the end of the fermentation period, I tested the alcohol levels with a hydrometer and a refractometer. The results indicated that corn produces the highest concentration of ethanol.

SEE116: How Do Weather and Precipitation Affect the Levels of Contaminants in Tap and Well Water?

Water quality can vary from place to place and is measured by several factors, including bacteria and salinity levels. Drinking water is expected to contain some level of contaminants, but if drinking water travels through systems that are not properly maintained, this might create conditions that will increase the risk of contamination, which can pose a health risk for people and ecosystems. It is important to have clean drinking water, and to know if your water contains harmful contaminants. For my project, I wanted to test how different weather conditions and precipitation levels will affect the levels of multiple contaminants in tap and well water. To test this, I measured the weather conditions, precipitation levels, and temperature every day for 45 days. I also used a salinity testing kit to test the level of salinity in the tap and well water. I used testing strips to measure the amount of lead, iron, and chlorine in the tap and well water. To ensure these variables were controlled, I let the water source run for ten seconds before collecting the 10 mL water sample that was used for testing. My hypothesis was not supported by my results. I found that the tap and well water had nearly the exact same levels of contaminants, and that the contaminants did not significantly change depending on the weather conditions, precipitation, and temperature.

SEE117: Plants Response to Resources Surrounding U.S. Steel

In total, 8.3 million people have been killed from air pollution, but no one is ever able to completely escape the devastating consequences. But what about plants? The intent of this experiment is to grow different plants using water and soil from U.S. Steel and differentiate the flora to the same grown plants, but grown with dependable store bought water and soil. Plants have been placed into a secured area and are being grown with grow lights and handled with safety gear and will continue to grow for the next 3 weeks. Data will be collected through the measurement of plant growth, observing main artifacts of the plants structure, and even foliating patterns. The results of this project are far from just being the conclusion of a science project, rather the beginning of resolving a problem that has affected people globally. I look forward to getting my results and making as big of an impact as I can along with continuing to work with those who retain a wider platform to make a difference and find the truth that is owed to so many.

SEE118: Bioluminescence of Glofish

A popular household pet for new owners is glofish (Zebra Danio) for its stunning glow. To enhance their glow and marketability, scientists found that using blue lights increases the bioluminescent glow given off by the fish. However, another question is if bioluminescence can be controlled by covering the tank with various levels of dark material, altering the light absorption by the fish. The bioluminescence is measured with a Vernier Spectroscope with Spectrometer Optical Fiber. This natural way of altering their glow can be used in non-invasive medical research, with safe ways to track genes and cells using glofish bioluminescent genes.

SEE119: Detecting Microplastics using Dyes

Plastics are a part of almost every element of our lives. Whenever they break apart the create microplastics that become show up in our ecosystems, water, and food sources. In this project I will be using common dyes in order to be able to detect microplastics in a solution. I will be testing both Nile Red and RIT Pink in order to find the best process to dye various types of microplastics. Through this experimentation I will create a procedure that can be used to test various sources for plastic contamination. The experiment is ongoing, and results will be available the day of the event.

SEE120: Artificial light effect on microbiomes

The light reactions in photosynthesis are dependent on a source of light and water from the soil. The objective of this experiment is to observe if the light source and the time soil was exposed to the light had an effect on the soil itself. Alfalfa was grown under the same conditions initially and transferred to different lightings (natural light, grow light, or artificial light) for a four week testing period. After that time, the soil was tested for the pH along with presence of nitrogen, phosphorus, and potash. The results of this experiment showed that the pH, nitrogen, and potash remained the same while the phosphorus decreased in certain conditions.

SEE121: How Does Pipe Runoff Affect the Water Chemistry in Creeks?

Please visit student's exhibit for abstract

SEE122: The Impact of Oyster Mushrooms on Glyphosate Accumulation

Glyphosate spills are detrimental to the environment and finding a way to clean up the chemicals in a sustainable way is imperative. I will be testing to see if oyster mushrooms can break down the herbicide glyphosate into non-harmful compounds.

SEE123: Assessing Health of Lowber Treatment Site Runoff Water through Macroinvertebrates

This project focuses on evaluating the effectiveness of the Lowber Treatment site in sustaining macroinvertebrate life in water impacted by past coal mining. The treatment site is designed to purify iron-saturated water before it enters Sewickley Creek. I hypothesized that there would be very little macroinvertebrate life in the runoff water because the water still looks very orange after treatment, so it seems like it would be difficult for organisms to survive. To determine if the water quality could sustain macroinvertebrate life, I collected a sample using 3 1-minute kicks from the site and then identified them using microscopes and dichotomous keys. Using research from a study done at Lake Creek, a healthy and nonpolluted creek, as a control group it showed similar densities and EPT index values, suggesting positive water quality at the Lowber site. The EPT index for the Lowber site sample was 95.9%, and I found a total of 47 Caddisflies and 2 snails. The presence of caddisflies suggests a thriving aquatic environment because they are very pollution intolerant organisms, emphasizing the treatment site's effectiveness in preserving water quality. Based on the data the conclusion aligns with a null hypothesis.

SEE124: A Comparison of Precipitated Silica in Clay-Rich Soil to Other Soil Amendments

A prevalent agricultural challenge in the Pittsburgh area is the management of clay-rich soil, known for its dense texture that restricts oxygen and nutrient uptake by plant roots. To address this issue, farmers and gardeners commonly employ soil amendments, which either alter the soil's physical or chemical composition to improve its texture. A previous project has demonstrated the effectiveness of precipitated silica, an amorphous form of SiO_2, in enhancing soil aeration and texture as a physical amendment. However, optimal application levels of the precipitated silica remain uncertain, and direct comparisons with other popular amendments were lacking. Amendments such as sand, a physical amendment, or gypsum, a chemical amendment, are very popular choices for gardeners, but they both come with their faults, such as nutrient leaching. To address these gaps, this study serves to compare the effects of precipitated silica, sand, and gypsum on plant growth. Various ratios of precipitated silica were tested (1.5%, 3%, and 6% by mass) alongside the controls and traditional amendments of sand and gypsum in their optimal ratios. Sixty pots of marigolds were planted in clay soil, with measurements taken for pH, biomass, nutrient and water retention, and soil texture at the end of growth. A cost analysis will also be performed to determine the best holistic choice for a clay soil amendment. The initial hypothesis was that higher ratios of precipitated silica would yield the best results with high nutrient retention levels, biomass, and cost effectiveness. Results will be available the day of presentation.

SEE126: The Effect of Temperature and pH on Algae Growth

Please visit student's exhibit for abstract

SEE127: Effects of Trace Sunscreen Contamination on Green Algae Growth Rate and Photosynthesis

Green algae, an autotrophic organism, helps maintain overall health in marine ecosystems. However, pollutants, specifically UVA and UVB-blocking substances, can hinder its growth. Using trace amounts of various chemical and mineral-based sunscreens, we tested the hypothesis that all sunscreens, including those marketed as reef-friendly, harm the growth and photosynthesis of green algae. Nannochloropsis oculata cultures were exposed to 0.01% sunscreen solutions to model a contaminated marine ecosystem. We tested four categories of sunscreen: chemical-based including oxybenzone (CO), chemical-based excluding oxybenzone (CNO), partially mineral-based (PMB), and fully mineral-based (FMB). Over 20 days, we studied cell growth and chlorophyll levels via optical depth measurements and green pixel intensity (GPI) software analysis. By day 20, net optical depth in contaminated cultures had reduced by at least 11.1% when compared to the uncontaminated control culture. Green pixel intensity in contaminated cultures had declined by a minimum of 3.125%. On days 7, 10, and 12, the rate of decreasing optical depth began declining in the CO solution, the CNO and PMB solutions, and the FMB solution, respectively. On days 5 and 10, chlorophyll production began declining in the CO and CNO solutions and the PMB and FMB solutions, respectively. This study showed that mineral sunscreens marketed as reef-friendly still harm green algae and indirectly harm marine ecosystems. All contaminated cultures produced negative results compared to the control culture, suggesting that most sunscreen products may harm marine ecosystems. Further experimentation should discern the degree of harm caused by specific ingredients.

SEE128: Temperatures impact on cloud opacity

This study delves into how temperature fluctuations affect cloud opacity, shedding light on Earth's atmospheric processes. Through analysis, the research explores the relationship between water temperature changes and cloud formation using lumens as a comparison. Warmer temperatures lead to less opaque clouds, while cooler temperatures result in greater opacity. By examining the relationship, It helps gain insight into fundamental mechanisms driving cloud behavior, offering valuable contributions to meteorological understanding. It also helps give insight to atmospheric processes for other use.

SEE129: Wind Turbine Replacements - Extraordinary Pollution Reduction

Wind turbines are dismantled using massive diesel driven cranes, and the process can take one to four days. The largest cranes range from 500 to 700 horsepower and can run steadily for consecutive days, not including travel time to and from the wind turbine wind farm. It takes two to four smaller cranes to help erect and dismantle one wind turbine. All these diesel drive cranes generate billions of pounds of very toxic byproducts: NOx, CO, VOC, PM/PM10, SO2, and CO2 - a naturally occurring gas. The wind turbine community estimates that over 340,000 wind turbines exist in the world. These turbines have a life span of 10 to 20 years and are replaced by more efficient wind turbines. Dismantling creates over 2 billion pounds of toxic pollutants. My solution is to replace the heavily toxic dismantling by crane with a very efficient explosive process and eliminate 2 the billion pounds of atmospheric toxins.

SEE130: Fertilizer Runoff and Algal Blooms

When too much algae grows inside of one body of water it is called an algal bloom. Many people do not know or understand how harmful algal blooms can be, but when there is too much algae nothing else can grow in that water. One of the main causes of algal blooms is too many nutrients, like nitrogen or phosphorus. Because of this, I am testing algae growth with different fertilizers to observe which produces too much algae.

SEE131: The Effects of Soil Acidity on the Biodegradation Rate of Starch-Based Bioplastics

The purpose of this experiment is to determine the effects, if any, of varying soil acidities on the biodegradation rate of starch-based bioplastics. With biodegradable plastics becoming more important in the face of pollution, ascertaining the factors that affect the rate of biodegradability can aid in the creation of more efficient plastics with a higher rate of biodegradation. Three starch-based plastic straws were placed in clear containers and submerged in dirt with pH levels of 3, 6, and 9. The plastic straws were observed and weighed at the end of every day to measure and record the rate of biodegradation. Experimentation is continuing, and results and analysis of the results will be available during the fair.

SEE132: Roundup Pesticide Effects on Bean Plant Growth

Introduction Many farmers or other people who work in agriculture use herbicides to kill weeds that ruin their crops. These herbicides most often kill the desired weed but may have harmful non-target effects on crops in the surrounding area. In this experiment, the researcher will test to see if the herbicide Roundup has harmful non-target effects on bean plants. By doing this, agricultural workers can terminate the usage of harmful herbicides and utilize safer alternatives. The hypothesis is that Increasing amounts of Roundup applied to bean plants will cause harmful effects. The null is that increasing amounts of Roundup applied to bean plants will not cause harmful effects. Some of the technologies I will be using are as follows: scale, pipette, test tube, and hose. Conclusion After the experiment had concluded. The researcher noted that the soil with increasing amounts of roundup applied to it had fewer and smaller plants. These results give the researcher a good foundation to reject the null hypothesis.

SEE133: Climate Change and Seed Germination Rate

The purpose of this project is to determine the effects of heat stress on the germination rate of seeds and if it has an effect, what level of heat affects the seeds most drastically. A journal entry titled, Mechanism of Delayed Seed Germination Caused by High Temperature During Grain Filling in Rice, explained that heat decreases seed germination when grain is planted in a field. The seeds germinated much later and less successfully (Suriyasak, et al., 2020). In this study, a lab experiment was done to verify the findings of the article in a controlled lab environment. The following hypothesis was formulated, heat stress will decrease the germination rate of seeds. Sweet pea (Lathyrus odoratus) seeds were chosen for my test and different temperatures were chosen based on temperatures that sweet peas could germinate in, as well as lower and higher temperatures based on the temperature sweet pea seeds typically germinate in. Three seeds were placed in paper towels and placed into Petri dishes. This process was repeated fifteen times for each group. The seeds were left in the incubator for thirteen days until most seeds were germinated. The results showed that it was between 26^{o}C and 23^{o}C. There was no statistical difference. But there was significance between 32^{o}C and 26^{o}C as well as 32^{o}C and 23^{o}C. This shows that high temperatures do affect the germination rate of sweet pea seeds. The data supports the hypothesis.

SEE134: The Effects of Activated Carbon on Contaminated Water

Please visit student's exhibit for abstract

SEE300: Conservation of Condensate Water

Please visit student's exhibit for abstract

Medicine / Health / Microbiology (SMH)

SMH100: AP2B

Background: Invasive lobular carcinoma (ILC) is responsible for 10%-15% of invasive breast cancers, and ILC is the second most common type of breast cancer after no special type breast cancers (NST). ILC is understudied and currently lacks appropriate research models for studying the disease. Currently patients with ILC are receiving the same types of treatment plans as those with NST and are having worse outcomes. Previous data from our lab showed that AP2B is the top differentially methylated (hypomethylated) gene in ILC, leading to an increased expression of AP2B in ILC compared to NST breast cancer. AP2B is a transcription factor protein that regulates genes that control cell division, stimulates cell proliferation, and is involved in tissue development. Methods: Immunohistochemistry (IHC) staining was performed in the following models: human breast cancer cell lines (MCF7, T47D, MM134, MM453), patient derived organoids (PDOs), mouse xenograft tumors (MM134), and clinical tumor samples (six ILC tumors, six NST tumors). PDOs were generated by our lab from patient tissue samples and then grown in culture. All samples were embedded in FFPE blocks, sectioned, stained, and imaged. Results: There is increased expression of AP2B in ILC models compared to NST models. Staining showed that the expression of AP2B is heterogeneous across all models studied. Conclusion: The results of this study showed that increased expression of AP2B is a potential biomarker for development and progression of ILC. Thus, further research is necessary to understand the role that AP2B plays in the development of ILC.

SMH101: May All Your Swishes Come True

This study searches into the domain of basketball shooting accuracy, focusing on the nuanced differences between male and female players across various shot types. With the growing emphasis on gender equality in sports, understanding these distinctions can contribute significantly to tailored training programs and equitable opportunities for players of all genders. The study examines the shooting performances of male and female basketball players across different shot types, including jump shots, layups, and free throws. Data collection involves observational analyses of players' shooting performances in controlled environments, ensuring consistency and accuracy in measurements.

SMH102: The Affect of Food Pigment Concentration on the Heart Rate of Daphnia Magna

Please visit student's exhibit for abstract

SMH103: A Study of Diversity and Abundance in Nasal Microbiome Transcriptomic Profiles Among Asthmatic Individuals

Asthma, a predominant chronic condition among children, presents a multifaceted etiology, affecting 300 million individuals globally and imposing an annual $80 billion economic burden in the US alone. Recent strides in microbiome research have highlighted a pronounced link between microbiota dysbiosis and asthma pathogenesis, particularly within the gut microbiome, offering new avenues for intervention. However, the nasal microbiome, despite its critical exposure to external bacteria, remains inadequately explored. This study examines the Meta-transcriptomic profiles from nasal brushings of 694 asthmatic or healthy Puerto-Rican children, aiming to elucidate the role of the nasal microbiome in asthma. Utilizing alpha and beta diversity measures, Wilcoxon test and Differential Abundance Analysis, we found that asthmatic patients were notably more diverse and abundant with certain pathogenic bacteria. Asthmatic individuals exhibited increased microbiota richness, evidenced by elevated values in Shannon's index ($p = 7.6E-04$). Noteworthy disparities in species abundances were also discerned; protective species like Corynebacterium ammoniagenes were downregulated in asthmatics ($adj_p = 9.9E-3$), while pathogenic strains like Staphylococcus aureus ($log2FC = .12$, $adj\_p = 7.95E-05$) and Staphylococcus pseudintermedius ($log2FC = .04$, $adj\_p = 1.24E-07$) were upregulated, aligning with existing literature. Particularly noteworthy is the discovery of Staphylococcus pettenkoferi ($log2FC = 8.50$, $adj\_p = 4.50E-14$), a relatively unexplored pathogen, which may hold significant implications for asthma pathogenesis. Our findings reinforce the established body of research, introduce novel insights enhancing diagnostic precision and opening new research pathways. The study emphasizes the nasal microbiome's crucial role in the comprehension and management of asthma, paving the way for future investigation in this under examined domain.

SMH104: Stop the Bleed

When most people get a small cut on their skin, it bleeds for a while and then stops. This process is called hemostasis and is important because too much blood loss can be very dangerous to the human body. An essential part of this process is called coagulation or, more commonly, blood clotting. How does coagulation cause bleeding to stop? There are four key components of hemostasis. Platelets, clotting factors, fibrin and specific cell types (red and white blood cells) are normally found in the blood which all come together to help plug the wound. When this process does not work correctly, it causes blood disorders. One disorder is hemophilia, a genetic disease causing people to bleed excessively because of missing clotting factors. About 1 in 5,000 males are diagnosed with hemophilia. It is rare in females because of how it's inherited. This project, through a blood simulation, will analyze how an anticoagulant affects coagulation, and how disrupting coagulation can cause blood disorders such as hemophilia.

SMH105: The Exploration of the Activity of Calpain Released through the ABCA1 in Mast Cells

Mast cells (MCs) are white blood cells found in the connective tissue throughout the body. They release important inflammatory mediators and cytokines to fight foreign invaders. Unfortunately, these cells are also associated with inflammation due to autoimmune responses (allergies). The process of transmembrane transport has been discovered to release the protease calpain through the ABCA1 transporter. Historical laboratory data indicated that the calpain caused vascular leakage in vivo in mice. To confirm that it was the calpain's enzymatic activity causing this, a blue ear experiment was completed. Six mice were injected with Evan's blue dye then the treatments later. After being euthanized, biopsy punches of the ears were taken, and the optical density of the leakage in their ears was measured using a nanodrop machine. The results confirmed that calpain's enzymatic activity caused a significant amount of vascular leakage. To determine what calpain does to mast cells, MCs were isolated from the peritoneal cavities of two mice. The PMCs were grown for 21 days then treatments with varying amounts of calpain were given. Using flow cytometry avidin, CD117, LAMP1, and FCεRI were looked for as markers of degranulation. However, it is important to note that the LAMP1 stain did not work for the control, making this data unreliable. To conclude, calpain causes vascular leakage. It is not known what the calpain does to mast cells directly as it does not appear to cause degranulation.

SMH106: Determining Protein Levels of Key Factors Involved in Macrophage Metabolism

Background: Macrophages are phagocytic cells found in every organ that specialize in tissue repair, homeostasis, and development and the ingestion of bacterial cells and debris. The function of tissue-specific macrophages are dependent on specific stimuli, such as cytokines and growth factors in their microenvironment. These specific signals dictate their gene expression and their behavior. Alveolar macrophages have a critical role of breaking down surfactant in the lungs to assist in gas exchange. The goal of these experiments is to determine how various signals regulate macrophage gene expression and function. Methods: To investigate the role of GATA2 in alveolar macrophages, we used two different techniques to measure protein expression. To explore the role of GATA2, we used the Bronchoalveolar Lavage method to harvest the alveolar macrophages to then be plated and stained via IF staining to detect our (antibody). The purpose of this preliminary experiment is to ensure that GATA2 isn't expressed in knockout mice. After this experiment, we culture bone marrow derived macrophages by extracting monocytes from mice femurs. Next, we rinse the bones to obtain our monocytes. The monocytes are then stimulated with M-CSF to differentiate them, and then GM-CSF to make our macrophages to behave specifically like alveolar macrophages. We take the samples and use the lysates from the cells to quantify the proteins that were previously in the cell via electrophoresis. Results: Our images from the Western show that when our lysates were stimulated with GM-CSF, there was an increase in P-GATA2(Ser401), total GATA2, and in PPAR gamma. On the contrary, we see a decrease in P-GATA2(Ser192) when stimulated with GM-CSF. Conclusion: From our Western Blot experiment we can conclude that the proteins: P-GATA2(Ser401), total GATA2, and in PPAR gamma, are more reliant on the GM-CSF signal to be expressed than P-GATA2(Ser192).

SMH107: Matters of the Heart

Heart rate and blood pressure vary depending on the body's level of rest and activity. In this science experiment, I explored how our heart rate and blood pressure change based on our level of activity. From rest to various physical activities, I investigated the dynamic shifts in these vital signs. I involved female participants aged 13 to 15, measuring their blood pressure and heart rate to assess overall heart health. The study involved performing different activities, and measurements were taken before, during, and after each task. The results were graphed and compared over time. Notably, it was observed that boarding the bus before a basketball game led to an overall increase in blood pressure, while practicing basketball caused a general rise in heart rate. These findings shed light on how specific activities impact our cardiovascular system and contribute to our understanding of maintaining a healthy heart.

SMH108: Generating Mx2 Knockout Cell Clones for Studying Nuclear Import

Background: Retroviruses such as human immunodeficiency virus (HIV-1) are a family of RNA viruses that reverse-transcribe their RNA into DNA and then have the unique ability to incorporate that DNA into the host genome. Lentiviruses, like HIV-1, are able to hijack certain nuclear import pathways to infect host cells. Studying nuclear import is important for understanding the mechanism by which these viruses infect cells. The nuclear pore complex (NPC) is located on the nuclear envelope and regulates which proteins enter and exit the nucleus. Mx2 is an interferon-stimulated antiviral protein that localizes to the NPC. Mx2 prevents HIV-1 from entering the nucleus and also blocks certain cellular proteins from entering the nucleus. For this study, we will use CRISPR/Cas9 technology to create knockout Mx2 cell lines and investigate how Mx2 regulates nuclear import and viral infection. Methods: To generate Mx2 knockout HeLa and HT1080 cell lines, we used CRISPR/Cas9; gRNAs were designed to target the second exon of Mx2, which contains the start codon. Following dsDNA break formation by Cas9, the cells will repair the DNA using non homologous end joining, resulting in a lack of Mx2 protein expression. To identify Mx2 knockout cell clones, we performed a western blot and probed with antibodies specific for Mx2. We then wanted to determine whether the cells were knockouts at a DNA level. PCR primers were designed to amplify the region where the guides cut to see if one or both guides successfully cut. The resulting bands were cut from an agarose gel, then purified and sequenced. Results: Following an initial screen, 17 candidates were selected for follow-up. Six HeLa Mx2 knock-out candidates were screened using PCR and a second western, and, unfortunately, all six failed this follow-up screening and were expressing Mx2. Five HeLa Mx1 knock-out candidate clones are in the process of follow-up screening. After being confirmed by both PCR and western blot, one Mx2 knock-out HT1080 cell line, 30T.38, was determined to be a true knockout and its sequence has been verified. Further screening must be done to determine whether any other cell lines were successful knockouts. Conclusion: We have successfully generated a Mx2 HT1080 knockout cell line and will continue to identify additional clones. These knockouts will eventually be used to help us determine how Mx2 affects nuclear import.

SMH109: Macrophages Regulate Healing-Associated Fibroblasts in Diabetic Wounds

The healing of diabetic foot ulcers is often hindered by a disturbed tissue environment characterized by abnormal inflammation, new blood vessel formation, and scar tissue development. Notably, changes in the characteristics of macrophages and fibroblasts have been observed within diabetic wounds. A particular group of fibroblasts, known for their high expression levels of enzymes like MMP1, MMP3, MMP11, and proteins known as CHI3L1 and VEGF-A, appears to play a vital role in successful healing of diabetic wounds. Yet, it remains unclear if macrophages exert any regulatory control over these critical fibroblasts in diabetes. To explore this, we utilized bioinformatics by analyzing public patient data to pinpoint genes that are notably different in diabetic conditions. Using a diabetic mouse model, we found that certain interleukins and growth factors were less present in diabetic wound macrophages, and similarly, the expression of key healing components in the fibroblasts was reduced. When diabetic macrophages were co-cultured with fibroblasts from non-diabetic wounds, a significant reduction in the fibroblasts' healing factors was seen. However, when non-diabetic macrophages or diabetic macrophages that had been treated with IL6 were added to the co-culture with diabetic fibroblasts, we noticed an increase in these healing agents. The same positive effect was seen when we introduced IL6 directly to macrophages in diabetic mice, leading to enhanced wound healing and blood vessel formation. This data suggests that macrophages have the potential to regulate the healing capabilities of fibroblasts, and where diabetes impairs this ability, IL6 could be a key to restoring their healing prowess, offering a hopeful therapeutic route for those suffering from diabetic foot ulcers.

SMH110: EyeSpeak: A Real-Time Non-Invasive Tear Test for Detection of Major Depressive Disorder

Major Depressive Disorder (MDD) is a mood disorder affecting over 280 million individuals globally. While widely treatable, less than 25% of MDD patients receive proper diagnosis and treatment. Early detection of MDD enables rapid intervention and treatment, saving lives. Current depression diagnoses rely heavily on patients self-reporting symptoms and lack quantifiable biomarkers, leading to a high rate of misdiagnoses. Due to misconceptions and lack of access to psychologists, especially in rural and developing areas, depression screening is unavailable to millions of people. This study investigates tear fluid as a non-invasive point-of-care test (POCT) for MDD. An LC-MS/MS-based-proteomics analysis was performed on tear samples from 25 MDD patients and 25 healthy controls. MaxQuant database searches revealed 1,042 proteins and subsequent Perseus quantitative analyses identified MDD protein expression patterns, where 122 proteins exhibited downregulation and 235 proteins exhibited upregulation. Three tear proteins, matrix metalloproteinase-9 (MMP9) (Log2FC=3.6, $p<0.001$), interleukin-8 (IL8) (MDD only), and STAM-binding protein (STAMBP) (Log2FC=2.9, $p<0.001$), were selected as MDD biomarkers based on fold change ratios, identification frequency, literature support, and antibody availability. ELISAs assessed MMP9, IL8 and STAMBP, demonstrating 100% accuracy in a validation cohort (n=20). To facilitate a real-time POCT, an electrochemical sensor using Sensit Smart Bio-sensor was developed by photochemical immobilization of corresponding antibodies to carbon electrodes. This sensor will be tested on a large MDD cohort to establish biomarker thresholds enabling patient stratification based on severity and guiding personalized and effective treatment strategies. This novel approach holds promise as a quantitative gold standard for MDD screening.

SMH111: An analysis of the electrical output of Microbial Fuel Cells using various media, and the effect on voltage of the Shewanella oneidensis bacteria.

There are tiny microbes everywhere around us, including in the soil, leaves, sediment, and food sources like dry rice and wheat. One type of unique microbe is a bacteria called the Shewanella Oneidensis. It can be found in aquatic ecosystems and sediment and can also be grown in a lab. Sheanella oneidensis can convert chemical energy into electrical energy, by releasing electrons and serving as a natural conductors of electricity. These microbes can be used to build microbial fuel cells or bacterial batteries. This study aims to measure the voltage output of various carbon sources and the Shewanella oneidensis bacteria and determine which produces the greatest voltage. Microbial Fuel Cells (MFCs) have the potential to be a source of electrical power in the future.

SMH112: Anti-fungal properties of spices

Some spices are known for their medicinal properties and health benefits. Therefore, the purpose of this project is to determine which spice has the strongest antifungal properties to determine which one can be used in preventative medicine. To do so, I tested 4 different spices which were turmeric, cumin, cinnamon, and clove. I alternated between two and three teaspoons eight times for each spice and made one group with no spice to compare to. Then, after one hour of rise time, I measured the change in height to determine which spice inhibited the growth of yeast the most. The dough with clove had the least change in height which led me to conclude that clove had the best antifungal properties, rejecting my hypothesis that turmeric had the best antifungal properties. In the future, I hope to test the antibacterial properties of spices by collecting data from various research findings and using technology to find trends and patterns in the data for future antibacterial treatments.

SMH113: Impact of Sucrose Concentration on Escherichia coli Growth

Sucrose has both beneficial and adverse effects on the gut microbiome - low amounts of sucrose restore microbial dysfunction, while higher sucrose diets cause imbalances by inhibiting the growth of beneficial bacteria. This occurs because sucrose functions as an efficient energy source for bacteria but also reduces water activity in solutions through osmosis, so there is a threshold at which the lack of water activity outweighs increased energy sources and growth is inhibited. Thus, this project aims to determine the sucrose concentration at which bacterial growth is inhibited, using a strain of Escherichia coli to model growth. Growth is tested at eight different exponentially increasing sucrose masses in liquid Lysogeny Broth with triplicates of each testing condition and is measured by a spectrophotometer with an optical density setting of 600nm. Averages of optical density and concentration data in the three samples per testing condition show promotion of growth from 0.00M to 0.0719M sucrose concentration, and an inhibition of growth beginning between 0.0719M and 0.3385M. Growth was completely inhibited at a concentration between 0.3385M and 1.310M sucrose concentrations. Data is in the process of further analysis for error and significance. Conclusions give a specific interval for further testing on the bacterial growth inhibition threshold and provide insights into gut health and dietary impacts on microbial balances in the gut microbiome.

SMH114: Are Your Hands Really THAT Clean?

This project tests to see if different hand-drying methods affect cleanliness. The idea behind this is to determine whether or not hand dryers or paper towels leave behind, eliminate, or increase bacteria on the hands after washing. Research and studies show that using a hand dryer can blow remaining germs in the restroom onto the hands, clothes, and even a person's face, but paper towels wipe away any excess bacteria left on the hands. The experiment consisted of 12 students in total between 8th and 9th grade. Each student had a preswab of their hands done before washing and drying and another swab taken after using a hand-drying method. The results showed that using paper towels will most likely decrease the amount of bacteria left on the hands, but the hand dryer is more likely to increase the amount of bacteria.

SMH115: Studying the Role of Quiver in the Planaria

The aim of this experiment is to examine how the role of quiver affects the planaria. This will be done with the goal of achieving a greater understanding of how this gene affects cellular regeneration and behavior. Planarian flatworms will be used as a model in order to complete this goal. Quiver will be isolated and cloned using a polymerase chain reaction. The polymerase chain reaction will be used to amplify the gene sequence from a sample of cDNA. The product will then be joined into a circular plasmid using a ligation. Then a bacterial transformation and isolation of the recombinant plasmid will be performed. When cloning is successful, the activity of the gene will then be knocked-down in order to assess its role in cellular regeneration after the planarian has undergone amputation. While the study is currently ongoing, data will be collected by quantifying the regenerating cells and comparing results to a control group that did not receive the gene therapy.

SMH116: Drug Treatment in Vivo Using a Mouse Model of Retinitis Pigmentosa

Please visit student's exhibit for abstract

SMH117: Dermal Fibroblast Cell Growth Using Prosthetic-Based Scaffolding

The purpose of this study is to determine if human dermal (skin) fibroblast cells are able to successfully grow on different types of biopolymers. Skin cell growth on biopolymers could lead to prosthetics that can bind to skin, thus leading to medical advancements in skin regeneration. The three biopolymers used in this study are collagen, a carbohydrate, and a protein. In tissue culture experiments, skin cells are typically grown on sterile pre-coated plates. To test the binding compatibility between biopolymers and skin cells, this study uses three sterile six-well plates, with three wells on each plate coated with sterile saline, and the other three wells each being coated with one of the three biopolymers mentioned above. All three plates are incubated overnight at 37 degrees Celsius. Then, a known concentration of skin fibroblast cells is added to all the wells of all three plates followed by an overnight incubation at 37 degrees Celsius/5% CO2. The cells are checked every 24 hours and incubated until one of the biopolymers is completely covered with these cells. These cells are then detached from the plate using the enzyme trypsin, counted using a microscope using a hemocytometer, and the number of cells per millimeter is calculated. This process is repeated twice to support accuracy. The biopolymer that supports the most number of cells will be considered the best biopolymer. This experiment is ongoing, and results will be available on the day of the fair.

SMH118: What is Bloods Strongest Buffer?

The purpose of this experiment is to determine what buffer system in blood, if any, is the stronger of the three, and if they are together. It is hypothesized that the carbonic acid buffer will be the strongest, and the buffer systems being tested (Protein, carbonic, and phosphoric) will be slightly stronger together. Different solutions of these buffers will be titrated with a strong base or strong acid, and this will be analyzed to determine how effective they are compared to water, which will be the control group in the first set of tests. The second set of tests will involve the combining of buffers and this will be analyzed in a similar way. The analysis will involve the amount of acid or base titrated, and this will be statistically analyzed using a T-Test or anova depending on the stage. The analysis will be available at the fair.

SMH119: Assessing the Impact of Exercise on Endometriosis-Related Symptoms

Endometriosis is a condition in which endometrial-like tissue grows outside of the uterus. Though this condition affects approximately 10% of reproductive-age women, it is rarely cited in teenage females. Because it takes time for a diagnosis of endometriosis to be achieved, many young women may experience its symptoms for a while before receiving confirmation of its presence. Because of this delay, studies about endometriosis can neglect younger female populations. This study looks specifically at this younger population to consider how exercise impacts endometriosis-like symptoms. Through the use of a survey, participants will provide data about their exercise habits, the presence of symptoms often associated with endometriosis, and the impact of one upon the other. This data will then be analyzed to look for relationships between exercise and endometriosis related symptoms. This data may then be used to provide exercise recommendations for pain management. If a large enough study population exists, a follow-up study can take place considering the role of age on the link between exercise and endometriosis symptoms.

SMH120: Exploring Pittsburgh's Urban Microbiome

I aiming to answer the question of what species of bacteria can be found in the Oakland area of Pittsburgh. Cities are where some of the most diverse urban microbiomes, the interaction between microorganisms in urban environments, form. Densely populated cities where people from all over the country and world gather is 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 to when deepening our understanding of urban microbes and their possible affect on human health. To identify what species could be found in oakland I took samples of the outside doorknobs of the 5 most popular restaurants in oakland, washing the plates and sequencing gDNA collected from all the bacteria on the plate using a Nanopore MinION sequencer. The rationale for choosing door knobs is because people are constantly touching them in restaurants, especially because someone may not wash their hands before eating. In this interaction it is possible that whatever bacteria that may have come in contact with their hands may enter the body. Using blood agar plates to grow my bacteria and letting those incubate at 37.2^{o}C over 24 hours to start. I then washed the plates with liquid LB and purified gDNA from my samples using a qiagen kit. When purification of the DNA and library prep is complete I will be able to conclusively say what microbes are living in oakland.

SMH121: The Effect of High-Volume Background Music on Vocal Music for Hearing Aid Users

Dynamic range compression is a quality of hearing aids that adjusts the volume of sounds to make loud sounds quieter and quiet sounds louder. It is intended to make all sounds in human speech within a comfortable volume range for the human ear. However, when dynamic range compression is applied to multiple sounds at one time, it can result in a lack of clarity and sound quality because the unnecessary compression of certain sounds can make music unenjoyable or even inaudible. The purpose of this study is to determine if reducing the volume of loud background instruments can improve the music listening experience for hearing aid users. The decibel levels of the instruments in two songs, Tusk and Tangerine, were measured, and the volume of the instruments that were originally louder than the vocals was reduced. Then, both the unedited and edited versions of both songs were played for hearing aid users with slight to moderate hearing loss. These participants then rated several aspects of each song, such as overall enjoyment, lyrics understanding, and distortion. The results showed that adjusting the volume of loud background instruments can improve the music listening experience in some ways, such as lyric understanding, but not in others. Due to the extremely personal aspect of hearing aids and hearing loss, further research should be performed on the most efficient ways to improve the quality of music for people with hearing loss.

SMH122: Comparing Diseases (TBD)

Please visit student's exhibit for abstract

SMH123: The Function of EGFL6 in Ovarian Cancer Biology, Tumor Initiation, and Therapy

High grade serous ovarian cancer (OvCa) is typically treated with surgery and chemotherapy. Unfortunately, OvCa has a low survival rate. As such new therapeutic targets are needed, and one is EGFL6. EGFL6 is a protein that is secreted by OvCa cells and drives cancer cell metatasis and proliferation. The goals of this project were to evaluate (i) the role of EGFL6 in tumor initiation and (ii) the ability of a new human-anti-EGFL6 antibody to neutralize EGFL6. Methods: To evaluate the role of EGFL in tumor initiation we used an ex-vivo organoid model. Fallopian tube epithelial cells (FTE the source of high grade serous cancer) from (i) wild type mice, (ii) mice over-expressing EGFL6 (iEGFL6), (iii) mice carrying tumor driving mutations (BPRN - BRCA1, p53, Retinoblastoma) in the FTE, and (iv) mice carrying BPRN driver mutations in the FTE and overexpress EGFL6 (BPRN-E). FTE cells were grown as organoids ex-vivo and the size and number of the organoids grown from each treatment was evaluated. To evaluate a novel anti-EGFL6 antibodies abililty to neutralize EGFL6 function, the cancer cell line SKOV3 was collected and treated with EGFL6 in the presence of control or EGFL6-neutralizing antibodies. Western blotting was then performed to evaluate the impact of EGFL6 on downstream activation of pERK (phosphorylated ERK).

SMH124: Testing AI in the medical realm

The purpose of this experiment was to solve the question of how far AI could take over jobs and research in the medical field, and how trustworthy AI could be. A Google form was created asking medical professionals to provide a diagnosis to a patient with symptoms of either Meningitis or Lyme disease. Their answers were compared to the answers AI provides. Through research AI can help patients correctly diagnose their symptoms stemming from basic health ailments but additional research would be needed to determine if it could be used for more serious conditions. This technology could help medical professionals lower down their patient rate in the hospital setting to limit sickness spread.

SMH125: Will Damaged Hair Affect the Amount of Oil it can Absorb

Does damaged hair collect the same amount of oil as healthy hair? The hair samples were collected from a hairdresser and carefully put into sealed bags. The hair was then looked at under the microscope and weighed on a scale. After all the starting data was collected, the hair was then moved into the oils. The oils used were argan oil, coconut oil, olive oil, and motor oil. The oils were placed into individual petri dishes and the hair was then added to them. The hair then sat in the oil for 24 hours. After 24 hours, the hair was then weighed again and looked at under the microscope. The data was then collected from the hair samples.

SMH126: Evaluation of metal-based antibacterial therapies

Evaluation of Metal-based Antibacterial Therapies Antibacterial and antibiotic drug resistance are two major concerns in microbiology and global health. Continued research into the development of metal-based therapies has shown promise in finding new approaches against otherwise untreatable bacterial spread. This research project explores the effect of existing antibacterial treatments alone and in combination with metal compound therapies. The research question being addressed is whether the addition of metal compounds would enhance the efficacy of existing antimicrobial treatments or not. It was hypothesized that if metal-based compounds are combined with preexisting antibacterials and antibiotics, their synergy will increase the potency of the observed results compared to using the treatments individually. The second hypothesis tested was that the addition of metal-based compounds would increase the potency in antibacterial chemicals significantly more than when a metal compound is added to antibiotics. Disk-diffusion assays were performed to measure the individual and combination therapies.- The results of the statistical analysis carried out with the collected data will be available on the fair day.

SMH127: Alternative Light Sources For Bioluminescence

This project intends to see if a specific light source allows bioluminescent dinoflagellates to flourish more than others. Comparing the light emissions from three different light sources when exposed to the bioluminescence (red, violet, and white) to see which one produces more light. The hypothesis is that the violet light will produce the most bioluminescent glow. Putting them into a 100% dark area with a single light source, and having them on their 8 to 8 rotation having access to light from 8 p.m. to 8 a.m. This is the time that was recommended with bioluminescence. Going to the 100% dark area around 9:00 a.m. to measure the light emission. Measuring the light emission with an app called Light Meter. The results of this project will be available on presentation day.

SMH128: Does bacteria found in frog slime inhibit BD?

Please visit student's exhibit for abstract

SMH129: Improving cell viability by regulating molecular weight of alginate solutions

Please visit student's exhibit for abstract

SMH130: Effects of Harmine on Beta Cell Proliferation: Identification of Novel Drug Targets for Type 2 Diabetes.

Type 2 diabetes mellitus epidemic, a common yet incurable disease has created a socioeconomic gap for receiving adequate treatment. Discrepancies exist at the small molecule level such that targets exist but none of them significantly reverse type 2 diabetes. DYRK1A inhibitors have been hypothesized to increase the proliferation of pancreatic beta cells. Namely a natural DYRK1A inhibitor Harmine derived from Peganum harmala L has potential to impact the proliferation but the exact targets are not tested. Thus the current study is focusing on identifying targets that stimulate the beta cell proliferation with this natural. To conduct this study a growth curve between harmine treated cells and untreated cells was followed. Further genetic analysis was done through cell culturing Insulin II(mouse insulinoma) with Harmine and assessing qPCR results of significant markers of beta cell maturation and proliferation. Novel Findings: Harmine maintains beta cell growth and significantly increases beta cell proliferation. Cyclin A1 (CCNA1) was a significantly increased -regulator of beta cell proliferation. MafA, Isl1, Glut2 all being increased is consistent with enhanced function. Cyclin A2(CCNA2), Cyclin D2 (CCND2), NFAT2 and 3, and Ins1 expression was low. Prior studies have found that in combination with Glucagon-like peptide-1 (GLP-1) CCNA2, CCND2, NFAT2, NFAT3 and Ins1 activities increase. Further as this study was solely treated with Harmine which could suggest an interdependence with GLP-1 mechanism of action and novel drug targets specific for only harmine.

SMH131: The Effects of Hand Sanitizer on Bacterial Growth

During Covid, everyone got used to using hand sanitizers. Almost all of the hand sanitizers say that they kill 99.9% of bacteria. Is that really the truth? In this experiment, I will test the effectiveness of a select group of hand sanitizers on bacteria. I hypothesize, of all hand sanitizers that will be tested, Purell Advanced Hand Sanitizer will kill over 99% of bacteria. To begin, my school purchased the bacteria staphylococcus epidermidis and agar for the experiment. My plan is to melt down the agar and pour it into around twelve different plates. Once the agar solidifies back into its gelatin-like form, I will use an inoculation loop to spread that bacteria on my plates and then place them into an incubator. Next I will take cotton swabs and do several separate streaks of bacteria on a tray. After doing that, I will then put different hand sanitizers on different swabs, streak them over the S. Epidermidis, and then take that swab and replate it on the agar to see if anything grows. This project is ongoing and results will be available on fair day.

SMH132: The Effect of Herbal Remedies on Stress

Please visit student's exhibit for abstract

SMH133: The Impact of Oxidative Stress on Biofilm Formation in Serratia marcescens

Approximately 1 million clinical appointments are made for keratitis annually, making it the primary cause of corneal blindness globally. Rising keratitis cases can be partially explained through widespread use of contact lenses, which are easily infected. Bacteria adhesion to the ocular surface is often made more effective due to the development of biofilms. Biofilms are surface attached communities of microorganisms that are better able to resist antibiotics and biocides. Biofilm production is thus thought to worsen the severity of keratitis. This research investigated the relation between the katE gene, biofilm production, and oxidative stress responses in Serratia marcescens. Several bacterial samples (one with a vector inserted copy of katE, the wildtype, and katE mutant) were investigated through adding hydrogen peroxide to each sample and measuring catalysis activity, and by measuring the development of biofilms in each of the samples. The results indicate that catalase production varies substantially between kateE and the wildtype. However, in high concentrations of hydrogen peroxide, samples without katE developed substantially poorer biofilms, indicating katE plays a role in response to oxidative stress. These results confirm that virulence in Serratia related keratitis cases is in part due to the bacterium's pili and adhesive abilities. However, the results showed no significant increase in biofilm formation by the addition of subinhibitory concentrations of hydrogen peroxide.

SMH134: Estrogen/Growth Factor Interactive Effects on Cancer Cells

This experiment aims to understand the impact of estrogen and growth factors on cancer cells. By combining these distinct endogenous factors, intriguing effects on the cancer cells can emerge. The objective is to observe the extent of change in cell growth resulting from this combination. Estrogens, as steroid hormones, facilitate the development and upkeep of female bodily characteristics, while growth factors represent substances, like vitamins or hormones, essential for stimulating cellular growth. The research intends to discern the individual effects of these hormones and evaluate their respective effectiveness.

SMH135: Protein Supplement Influence on Enzymatic Activity

This experiment is a demonstration of the effects of a protein supplement, collagen, on enzyme activity, specifically amylase and peroxidase. The results collected from the spectrophotometer as well as the size of starch digestion zones will determine the conclusions of this experiment. This research is important because, after a workout, protein supplements repair muscle damage with the help of enzymes, and if this experiment works, it will note the success of those protein supplements. However, if this experiment fails, and the pH drops or the value on the spectrophotometer is too low, this will show the failure of protein supplements.

SMH136: The Effect of Dark Chocolate on Alzheimer's Progression

Alzheimers is the most common kind of dementia, accounting for 60-80% of dementia cases. The greatest risk factor for developing Alzheimer's disease is aging. It is a progressive disease where symptoms worsen over time as a person moves through the 7 stages of the disease. Two treatments have been discovered for the disease, aducanumab and lecanemab; but there is currently no cure. The changes that arise in a person's brain result from abnormal beta-amyloid protein accumulation in clumps. These clumps are called plaques and they are located between neurons which block signaling between cells. The purpose of this project is to determine the effect dark chocolate has on the formation of clumps of beta-amyloid. I chose dark chocolate because it is high in concentrations of theobromine and flavonol which are known to be beneficial to the brain. These substances interact with the signal pathways involving protein and lipid kinases that lead to the inhibition of neuronal death by apoptosis. Using amyloid proteins derived from sunflower seeds as a substitute for beta-amyloid in the brain, I am going to assess the effect dark chocolate has on Alzheimer's disease by determining the concentrations of proteins after an incubation period alongside the chocolate. If it is less than what it was before then there is a suggestion that dark chocolate may delay or decrease the risk of Alzheimer's in aging individuals.

SMH137: Investigation of cell decision between therapy-induced cell cycle arrest and apoptosis in ovarian cancer

Background: Cellular senescence, permanent cell cycle arrest, theoretically represents a desired outcome for anticancer therapies. However, studies have demonstrated that therapy-induced senescence is reversible, allowing tumor cells to survive and reemerge years after the primary disease eradication. Hence, tumor cell cycle plasticity poses the challenge of therapy resistance and tumor relapse as arrested tumor cells regain proliferative capacity. Understanding the mechanistic pathways whereby tumor cells determine the fate between senescence and cell death under therapeutic stress is critical to developing combination therapies to address therapy-induced dormancy and tumor relapse. In this study, I investigate how ovarian cancer cells choose between senescence and apoptosis in response to therapy-induced DNA damage. Methods: Ovarian cancer cells OVCAR-8 with biosensors DHB-mVenus and 53BP1-mApple were treated with varying concentrations of chemotherapy drugs cisplatin and olaparib. Live-cell time-lapse imaging of fluorescent biosensors by the THUNDER Imager was used to track single-cell activity over five days. In the follow-up experiment, cells were treated with either a combination of cisplatin and Wee1 inhibitor or Cdk2 inhibitor, or cisplatin, Wee1 inhibitor, or Cdk2 inhibitor alone. Cell images were captured after five days and segmented using Cellpose for analysis. Results: OVCAR-8 cells performed apoptosis with high Cdk2 activity under drug treatment, as indicated by high cytoplasmic levels of DHB. Cells treated with Wee1 inhibitor and cisplatin demonstrated increased apoptosis than cells receiving only cisplatin. Conclusion: Our study suggests that tumor cells choose apoptosis in a state of confusion between the chemotherapeutic stress of DNA damage and the inability to shut down Cdk2 activity and halt cell cycle progression. Hence, combination chemotherapy of cisplatin and Wee1 inhibitor is a promising treatment that renders a potential solution to tumor relapse. Future studies will use cells with an additional PCNA biosensor to confirm the finding and distinguish the cell cycle phase in which cells commit to a fate.

SMH138: Dragon's Blood and Wound Healing

In rural communities, natural remedies are the backbone of healthcare. Dragon's Blood is a tree sap and natural remedy found all over the world, from Ecuador to China. The Croton lechleri genus of Dragon's Blood is an empirical cure in Ecuadorian rainforest communities, attributed to increased healing and decreased infection rates in wounds. However, little research exists that corroborates Dragon's Blood's wound healing abilites. When a wound healing assay is conducted, it typically utilizes animal cells. As recommended by the Wound Healing Society, porcine epithelial cells serve as the most effective model for the human epithelium, due to shared anatomical and physiological traits. This project investigates Dragon's Blood's wound healing potiential through two porcine epithelial cell wound healing assays. The first assay will simulate a normal wound, where a pipette tip will create the wound by piercing a cell monolayer in a 12-well plate. The second assay will utilize a pipette tip dipped in 3 different bacteria (P. fluorescens, B. thuringiensis, and E.coli) to simulate the introduction of pathogens into a wound area. These bacteria were used in a Zone-of-Inhibition assay in a previous experiment I conducted using Dragon's Blood, in which I investigated its anti-bacterial properties. Thus, Dragon's Blood's wound healing and anti-bacterial properties will be simultaneously investigated throughout the entirety of this experiment.

SMH140: Neoantigen discovery in melanoma patients treated with neoadjuvant CMP-001 and nivolumab

Background: Neoadjuvant intratumoral TLR9 agonists (CMP-001) and anti-PD-1 provide durable clinical responses in patients with high-risk respectable melanoma. Response is associated with broad immune activation, especially with increased activity of CD8+ cells in the tumor microenvironment and in the blood. Therefore, treatment efficacy may be driven by the immune response against tumor neoantigens. Neoantigens are peptides derived from mutations presented by HLAs and targeted by antitumor CD8+ cells. Vaccination against neoantigens is an interesting therapeutic approach for selectively enhancing T-cell mediated tumor killing. Objective: To evaluate the binding capacity of mutation-associated neoantigens derived from tumors of patients treated with CMP-001/anti-PD-1. Methods: Based on RNA sequencing data of the baseline tumor in a HLA-A2 responder patient, 91 mutant peptides of 9-11mer in length were identified and synthetized, along with their corresponding wild-type(WT) peptide. We performed a T2 Cell-Based HLA-A2 Peptide Binding Assay on 5 mutant peptides and their corresponding WT sequences. The peptides were added to T2 cell cultures at a concentration of 10ug/ml. T2 cells were incubated for 24h at 37ºC, then labeled using a PE-conjugated anti-HLA-A2 antibody and analyzed by flow cytometry. The peptide binding ability was calculated using the formula (MFIpeptide−MFIDMSO)/MFIDMSO×100%). We used MELAN-A27-35 and MAGE-A3146-160 as respectively positive and negative controls. Results: All the mutant peptides had a higher binding capacity than the negative control. Mutated peptides had a significantly higher binding capacity than their corresponding WT (Wilconxon matched-pairs signed rank test, p = 0.04). Peptides #36 and #43 had the most important difference in MFI ratio with their corresponding WT (respectively 352 versus 0 and 280 versus 0) Conclusion: Peptides #36 and #43 are good candidates for further evaluation of their immunogenicity and characterization of the CD8 cells that recognize them specifically. Other peptides will be similarly screened and the best ones proposed as targets for cancer vaccines.

SMH141: Role of two-component regulators in Pseudomonas aeruginosa cytotoxicity to corneal cells

Pseudomonas aeruginosa is a ubiquitous, gram-negative, bacterial species that can cause disease in plants, animals, and humans. Pseudomonas infections are a serious risk for cystic fibrosis patients and also cause a severe vision threatening infection known as keratitis. P. aeruginosa requires virulence factors, such as toxins to cause infection and how the bacteria turns on expression of these in response to the ocular environment is poorly understood. Two component transcriptional response regulator systems (TCS) are stimulus-response coupling mechanisms that allow organisms to sense environmental stimuli and respond to it through a series of kinase reactions, resulting in a transcriptional response. Pseudomonas aeruginosa rely on these systems to survive and proliferate. In fact, some TCS have been proven to control virulence factors, so understanding how they work could lead to virulence suppression. P. aeruginosa has over 60 TCSs, and the role of most of these in virulence has not been established. We hypothesized that two-component regulator systems (TCS) regulate pathogenesis to human epithelial cells (HCLE). The goal of this study was to find a TCS mutant strain of Pseudomonas aeruginosa that showed lower virulence levels. Then, we can target those TCS's that regulate virulence and possibly block them to prevent further cytotoxicity, leading to a new form of treatment. Certain TCS mutant strains exhibited slightly increased and majorly decreased levels of cytotoxicity to human cells. Indicating a positive or negative role for the TCS genes in controlling virulence. Certain mutants showed a decreased level of virulence, meaning that some change in the genome inhibited its potency. The data collected support the hypothesis that some TCS are necessary for virulence to corneal epithelial cells.

SMH142: Transcriptome signature revealed the mechanism of synergistic effect of Emodin to Doxorubicin in colorectal cancer cells

Please visit student's exhibit for abstract

SMH143: Probiotic Suppression of Pathogenic Bacterial Growth

Probiotics are the use of bacteria for the benefit of the patient. Probiotic bacteria have been shown to inhibit the growth of harmful bacterial species but may be limited in the bacteria that they are able to counteract. In this project, we sought to identify a novel probiotic bacteria that may be generally useful by showing that it has activity against both Gram-negative and Gram-positive bacterial pathogens. We isolated the bacteria from an environmental source (commercially available milk) and identified it as a strain of Lactobacillus delbrueckii. We used a co-culture assay in which the L. delbrueckii was co-incubated with Staphylococcus aureus (Gram-positive) and Escherichia coli (Gram-negative), two common human pathogens. The pathogenic bacteria had been modified to emit light, so we were able to monitor their growth in real time by simply quantitating the amount of light emitted by the culture. The L. delbrueckii strain we isolated was able to inhibit the growth of both pathogens, but in a slightly delayed fashion, after allowing an early period of growth. This may have been because the pathogens stimulated the production of an inhibitory factor from the Lactobacillus. We tested this idea by treating the conditioned medium of Lactobacillus with a protease, to see if that would remove the ability of the medium to suppress pathogen growth. It did, which suggests that the pathogens stimulate the Lactobacillus to make a protein that can counteract the pathogenic bacteria.

SMH144: Meat Preservative Antimicrobial Effects

Natural Preservation of Meat is a well-known process. The preservation of meats uses many ingredients, but the two main ones are sugar and salt. Chemical Preservation is a new process, as the ingredients are newer. The preservatives that were used in this experiment was a 65% sugar water solution, and a nitrite brine solution. There were three experiments that was run. The first experiment is an infusion of the solutions into 12 pork cubes. The second experiment is an infusion of the solutions into agar plates. The third experiment is 5 tubes of preservatives at different concentrations. All three of the experiments uses laboratory grade E-Coli.

SMH145: Pepper Extract Effects on Microbial Survivorship

This experiment was done to find out the effect pepper extract has on microbial survivorship. Capsaicin has shown antibacterial effects, so I tested them on two different bacterias E. coli and Staphylococcus epidermidis. There were 2 phases to this experiment. For the liquid infusion, pepper extract was made into solutions with sterile fluid to make concentrations of 0%, 1%, 0.1%, 0.01%, and 0.001% that were then added and spread onto plates. For the agar infusion, pepper extract was directly put onto the agar plates in a high and low exposure and incubated to allow infusion. Then bacteria were added to these plates and spread. After some data analysis, the null could be rejected for the 0.1% concentration on the liquid infusion and both exposures for the agar infusion on the Staphylococcus epidermidis. Also, the null can be rejected for the high exposure agar infusion for the E. coli.

SMH146: Post-Activation Performance Enhancement Effects on Power Output

The purpose of this project is to test the effects of a principle called post-activation performance enhancement (PAPE) on vertical jumping ability. Power output, especially through the legs, is an essential part of almost every sport. The concept will be tested with high school teenagers performing a procedure that includes a cardio and stretching warm-up to begin. After that, subjects will test their max vertical jump before performing a 5 second isometric contraction by squatting driving a barbell into the safety pins on a standard squat rack. Proceeding this, the individual will retest their vertical jump and the changes will be noted. Adequate rest time will be enforced to reduce the effects of fatigue.

SMH147: Honey Effects on Microbial Survivorship

In this experiment, potential effects of honey on E. coli and Staphylococcus epidermidis survivorship were investigated. The Purpose of the experiment is to determine whether different concentrations of honey will affect the bacteria, specifically the resulting number of bacterial colonies. The bacterial models were exposed to honey in a liquid exposure phase at 0.1%, 1% and 10% and agar infusions at 1% and 10%. They were incubated, and then counted. The results suggested that, for the liquid infusions, there was no effect on the E. coli and an increase in S. epidermidis for larger concentrations of honey. The agar infusions seemed to reduce the number of bacterial colonies with larger honey concentrations.

SMH150: Analyzing Genes Based on Polygenic Growth and Cell Repairing Gene Expression Contributing to Cancer; and Inhibiting Cancerous Metabolic Neuroreceptors

Analyzing genes using Magnetic Resonance Spectroscopy based on polygenic growth and cell repairing gene expression contributing to cancer. Using statistical data to find proportionate differences and inhibiting cancerous metabolic neuroreceptors with bio safe chemicals.

SMH151: Circadian Rhythms

Circadian rhythms are responsible for our daily routines following a similar pattern every day! These rhythms are like internal clocks that many living things, from animals to plants and tiny microorganisms, have. In humans, they can be influenced by factors like stress, physical activity, body temperature, and even different time zones. Picture it as your body's built-in clock, affecting things like how quick you react at different times of the day. This project dives into the world of circadian rhythms, and we'll be measuring body temperature and reaction time to see how they change throughout the day. It's like uncovering the secrets of our body's natural clock!

SMH300: Regulation of Tregs' lipid metabolism by APOC3

Introduction: T-lymphocytes make one half of the immune system, contributing crucially to the host's defense mechanism. The two subtypes of T-lymphocytes CD4 and CD8 cells are primarily pro-inflammatory in nature. The only known/established anti-inflammatory subtype are regulatory T-cells (CD4+ CD25+ FOXP3+). Previous studies in our lab have shown that Tregs accumulate in the small intestine/colon of ApoC3tg (Apoc3 overexpression) and LDLr-/- (LDLr knockout) mice which protects them from colitis. We hypothesize that in response to ApoC3 chylomicrons, Tregs become highly suppressive as they shift to intracellular lipid catabolic pathways. Methods: Organs (spleen, liver, colon) and cardiac blood were collected from Apoc3 WT, ApoC3 Tg and ApoC3 k/o mice. Spleen was processed for isolation of CD4+ cells via MojoSort enrichment kit and natural Tregs (nTregs) via FACS. nTregs, liver and colon were then processed for quantitative RT-PCR (qRT-PCR). Plasma isolated from blood was subjected to triglyceride assay (TG assay). Trypan blue staining was performed for cell count. Results: As expected the ApoC3 Tg mice had significantly higher triglyceride concentration. mRNA analysis interestingly showed increased expression of lipid receptors like LDRr, CD36 in the liver of Tg mice and almost negligible expression in nTregs. SRB1, another major receptor for lipid uptake, has expression levels opposite to CD36. LPL, the enzyme responsible for hydrolysing triglycerides, interestingly though, had increased expression in liver and colon of Tg mice. It was undetected in nTregs. Conclusion: Tregs in the presence of excess triglycerides (hypertriglyceridemia) become more active by inhibiting their uptake from the extracellular pool. Increased LDLr , SRB1 and LPL expression indicate that clearly. Such Tregs rely more on their intracellular pool of lipids which are skewed towards fatty acid oxidation (FAO).

Physics and Astronomy (SPA)

SPA100: Detecting Exoplanets with a Home Telescope

The quest to find life outside our solar system has seen an uptick in interest every year. My experiment intends to help accelerate this search by getting amateur astronomers worldwide involved in the discovery of exoplanets. To accomplish this we used only parts readily available to most people and put them in a setup capable of detecting exoplanets. The process begins by setting up the telescope and locking it on a star with tracking software. Throughout the night, the telescope will observe the star until the setup is taken down in the morning. After this, we analyze the data to search for deviations. Experimentation is still ongoing and the results will be available by fair day.

SPA101: Angle of Tennis Racket to Ideal Shot

The goal of this experiment was to find the correlation between the angle of the racket when swung and the placement of the ball when hit at the same velocity. A swinging device/apparatus was used to simulate the person hitting the ball with more consistency than a human, and a practice tennis ball pitcher was used to get the ball into motion. The tennis racket is clamped at a measured angle and set into motion on the machine. Tripping the spring from a distance, the racket hits the ball and places it into the court, some distance away from the ideal ball placement; a cross court shot within the singles lines.

SPA102: The effects of magnetic fields on the flow of electricity through a closed circuit

This experiment aims to better understand the relationship between magnetic fields and electric circuits. The setup consists of a clock, a device to measure the flow of electricity through the wire, two magnets, and a electrical outlet. The magnets will be held at different distances from the clock and outlet in different positions to find its effect on the electricity in the wire.

SPA103: Linear Momentum and Transfer of Energy in Shoes

There are an abundance of shoe types: running shoes, dress shoes, etc. All shoes initially come with a kilometrage (distance that can be traveled) in which after those kilometers have been passed, the shoe needs to be replaced. This is especially prevalent in shoes designed specifically for athletics. The intent of the experiment is to see whether or not the recommended kilometrage is there so the companies could make more money, by selling more shoes, or if it truly helps the athlete. After using different mechanisms to stretch, compress, and overall wear down the shoes (which are primarily Nike other than one shock-absorbant specific shoe), they will be dropped from various heights. When dropping the shoes, there will be multiple cameras at different heights next to a ruler/metterstick to record the height the shoe returned to (the height will be based on the lowest part of the shoe). If the shoes returned to a similar height as they were before worn down, then the suggested kilometrage would be false. Even though the data collection is still in progress, it is predicted that the shoes will return to a higher height after being dropped, showing that the kilometrage will indeed be to the benefit of the athlete. Overall, the cushioning of shoes very likely has a drastic impact on an athlete by cushioning their strides and therefore putting less strain on the foot.

SPA104: Variance in Magnetic Properties in Inorganic Hydrates

The magnetic properties of certain materials have a crucial impact on their role in uses in technology and industrial processes. This research delves into the correlation between crystal structures and magnetic behaviors of inorganic compounds, particularly inorganic hydrates, by examining the magnetic properties and behavior of three different Copper(II) Sulfates: Anhydrous Copper(II) Sulfate, Anhydrous Copper(II) Sulfate, Anhydrous Copper(II) Sulfate. In order to measure magnetic properties and characterize magnetic behavior, magnetic susceptibility of the compounds was measured and methods such as electron spin resonance spectroscopy were utilized. The findings of this study show distinct variations in magnetic susceptibility among the copper sulfate variations, suggesting that the presence and arrangement of water molecules significantly influence their magnetic characteristics.

SPA105: Estimating the star cluster m34's age using an HR Diagram

We have multiple estimates of the age of the star cluster M34, but I generated a new one with data I gathered at the Allegheny Observatory. I built an HR diagram based on images taken of M34 in 2 different color filters (green and red) over 3 different exposure times (5 sec, 30 sec, and 300 sec). From the data, I got the temperature of the stars and the absolute magnitudes, which are the x and y axis of the HR Diagram respectively. The HR Diagram lined up well with previous data and estimates the age of M34 at 10 - 100 million years old, which is slightly less than the generally accepted 200 million years old. Knowing the age of star clusters helps us learn about galaxy formation.

SPA106: How Nozzle Geometry Affects Rocket Performance

Please visit student's exhibit for abstract

SPA107: Concentration of Water Vapor and the Blocking of Damaging UV Rays

The goal of this experiment is to determine the density (if it exists) at which water vapor will fully block UV-B radiation. The current hypothesis is that the density will lie far beyond that seen naturally in clouds. The process for this experiment is to place a UV Meter under a glass box and fill the box with gradually increasing densities of water vapor to simulate a cloud. A UV light is then shone through the box into the meter to determine how much UV-B radiation is blocked. This process will be repeated either until failure or total blockage of UV-B radiation; final results will be available at the fair.

SPA108: Forced Flow of Newtonian Fluids into Bingham Plastics

Manufacturing and other large-scale processes require mixing of large volumes of fluids, and reproducibility and quality control depend on proper and complete mixing. Yield stress fluids are a class of materials-including many consumer products, foods, and construction materials including mortar, concrete and mud-that require an initial threshold stress to include flow after which they flow like standard fluids. I considered fluid jetting into yield stress fluids using a model yield stress fluid, which I characterized using rheometry. I then visualized jet penetration of water into the yield stress fluid including the kinetics and geometry. The results of experimentation showed that depth of penetration is primarily a function of viscosity whereas the penetration width varies with yield stress. As such, I also examined possible improvements to mixing using multiple jets to penetrate the yield stress fluid.

SPA109: PLA Fabricated Model Rocketry: Optimizing the Viability of Economical Miniature Spacecraft for the Uses of Asteroid Deflection, Seismic Documentation, and Water Detection on a Mass Scale.

Please visit student's exhibit for abstract

SPA110: Suspended in Superconductivity

Superconducting technology is being used more frequently than ever in the modern world. Specifically in transportation, superconducting technology is used to increase the speed of maglev trains in Japan, Korea, and China. The goal of my experiment was to learn something new about superconductivity and find out how superconductivity can be used to solve problems today and in the near future. My experiment tests the height of levitation based on specific metals when in superconductivity. To get these metals to this state, I cooled them down with liquid nitrogen/helium in some cases and then used a small neodymium magnet to demonstrate the Meissner effect. This effect proves that magnetic fields will be excluded by any metal labeled superconductive after the said metal is cooled to its critical temperature. Also known as Tc, critical temperature is the temperature at which a normal metal transitions into a superconductive metal. A few of the metals I used so far were tin, aluminum, lead, zinc, zirconium, tungsten, and titanium. As data is being collected, results will be available by the day of the fair. Soon, we will know which metal makes a magnet levitate the highest when suspended in superconductivity.

SPA111: Tracking the Expansion of the Veil Nebula

The Veil Nebula is the remnant of a supernova that exploded 8000 years ago. Due to the amount of energy released in this supernova, there is a chance that the Veil Nebula is still expanding, and birthing new stars, to this day. In my research, I analyzed photos that I took at the Allegheny Observatory of the Veil Nebula. I compared these images to images that were taken more than 100 years ago of the same nebula and saw if it had changed size at all. This project has the impact that it can help improve the accuracy of viewing the Veil Nebula on star charts and maps. This data will give us more understanding of the initial supernova. Once all of my data was collected, I processed the photos, stacked them, and adjusted the filters, I layered the new filtered stack on top of a photo of the Veil Nebula from over 100 years ago. I found that the nebula has expanded, and has birthed new stars.

SPA112: Engineering Design Decisions Used to Launch Satellites Using Rotational Motion.

Aerospace engineering is a field that is intriguing and rapidly evolving. My research project involves a new way of spaceflight through a company named SpinLaunch. As baffling as it sounds, my project requires spinning a low earth-orbit satellite in a centrifugal vacuum chamber, so fast that once the desired launching velocity is hit, it can be released vertically, resulting in the satellite becoming a projectile. The purpose of this is to explore a new way of spaceflight using cleaner and more efficient energy methods, as well as incorporating multiple launches to space in one day.. I am curious about how the required launching velocity of a low earth orbit satellite affected the engineering design decisions of SpinLaunch. My method to research this will be using multiple online sources to research this new way, and by also learning the physics behind the design. My most important findings are the design structure of the centrifugal vacuum, as well as the shape of the rotating arm launching the satellite. One of the most important things I found is, the arm is made out of stacked carbon fiber, and must be able to withstand the tension, also the centripetal force, while spinning the satellite at such high speeds. Another important aspect of this design is ensuring the machinery does not overheat. Overall, this project has struck curiosity even more, making me wonder, is it possible?

SPA113: Exploring the Limits of Simple Off-the-Shelf Soft Robot Component Fabrication

Soft robots, though gaining popularity for their versatility, have one drawback: high price due to manufacturing of complicated geometry. A solution is to modify readily-available flexible tubes using lasers to create joints at which the cross sections are asymmetric. Under pressure, tube bending could occur at these joints due to thinner sections inflating more than thicker ones. However, instabilities form at high pressure inflation, taking the shape of blistering in such asymmetrical tubes. Blistering causes a large balloon to form at the joint's thin section rather than uniform inflation, thus preventing the desired bend. Preliminary investigation confirmed this behavior, even leading to the bursting of one sample due to the blistering. This instability may be the reason why all bladder-inflation-based soft robots use custom parts, however this raises development costs. The purpose of this research is to determine what parameters of laser-erosion produce a reproducible movement without encountering the blistering instability. It is hypothesized that an increased laser engraving depth will cause bend angle to increase and bending radius to decrease, increasing circumferential width will decrease likelihood of instability while increasing bend angle (up to 270 degrees circumferentially, and increasing axial length will also decrease instability likelihood but decrease bend angle and increase bend radius. Once the instability occurs, however, bend angle and radius will go back to 0. Experimentation will consist of laser engraving many silicone tubes while changing the parameters above, inflating in many cycles, and collecting qualitative data of bend angle and radius and instability point.

SPA114: Application of Blackbody Radiation in En Masse Advanced Habitability Assessment of Exoplanets

What if the fundamental principles of matter, of thermodynamics, could be manipulated into an equation offering tremendous insights into the ubiquity of life on the worlds outside our solar system? In my past project, not only did I demonstrate this could be done, but I also created a novel model relating Blackbody emissions of exoplanets to otherwise unattributed error in their transits---isolating pivotal features of exoplanet composition with unprecedented ease. This year, I have worked towards the extension of this key relationship involving Blackbody Radiation---expanding this fundamental interrelation to develop an advanced habitability assessment for these faraway worlds. By subjecting my model to a larger dataset and applying further processes building upon the initial Blackbody emissions relationship, my equation is further substantiated and new avenues of exploring the characteristics of these worlds are developed. Previous planetary class determinations and analog world comparisons are used in tandem with new methods, and albedo, emissivity, among other characteristics related to this in-depth interrelation with Blackbody Radiation are applied. The exoplanet's determined composition is then considered holistically with the world itself: planetary size, proximity to the Goldilocks Zone, stellar radiation exposure, planetary density, among other features arising via this new underlying relationship. And so, this innate connection between the theoretical exploration of exoplanetary Blackbody Radiation is consolidated into an en masse assessment of planetary characteristics that reveal their ability to sustain life---thereby enabling a habitability assessment accessible by professional and amateur astronomers alike and accelerating the search for life in the universe.

SPA115: Effect of Wind on Sound

Musicians in concert bands usually proceed to do marching band during their high school and/or college years if they are passionate in music. A marching band is usually a group of musicians, whether they are brass, woodwind, percussion, etc., who generally perform in an outdoor setting, incorporating marching technique with musical arts. The intent of this experiment is to find how the intensity of wind affects a flute's sound quality, and to solve that by using a device, the Win-D-Fender. This project is a continuation of a previous experiment. By using more advanced techniques/tools, this year's project differs from last year's by yielding more significant, accurate, and precise results. Through the application, Phyphox, which uses phone sensors to measure the frequency of sound, 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. Two new fans, having a higher power output and a higher overall wind intensity were used in this continuation. Both fans used a scale of varying intensities from 1 (the lowest intensity) to 3 (the greatest intensity) to simulate wind. After finding significant results, a device will be used to block wind as a solution to the problem. While the experiment 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, and the device will solve wind affecting flute's sound.

SPA116: The Relationship Between Whirlpools and Black Holes

When conducting research on black holes, space companies like NASA utilize satellites and telescopes, which are costly and require utmost precision. Knowing that whirlpools share the same gravitational behavior as black holes, I will experiment to see how closely related the spin properties of whirlpools and black holes are. I will use a whirlpool device and create whirlpools at different rotational velocities, while placing a small wooden sphere to observe its behavior in the whirlpool during observation. Based on the observations and recordings made for each trial, I will determine how different rotational velocities affect the shape of whirlpools and their gravitational fields. After analyzing the data, I will determine if the data for each trial can be used to replicate a black hole proportional to each of the whirlpools' spin properties. This research will determine if whirlpools are a cheaper alternative to conducting black hole research regarding the spin property.

SPA300: Projection of Different Notes in voice sections

How does the projection of Higher and lower vocal ranges affect the decibel levels at different spots in an auditorium?