Coke Vs. Pepsi

Henry Ahern

The purpose of this experiment is to tell if taste buds are as strong as we think we are. People have strong opinions about cola brands.? Especially Coke and Pepsi products.? But can people really tell the difference in taste or is it that one company does a better job of advertising.

This concept was tested by putting soda in cups and see if participants can tell the difference between the soda , but they cannot know which soda was on which side.

It was found that over half the subjects could not tell the difference between the sodas . Of the 44 people tested, 21 guessed correctly in the blind taste test. While 23 guessed incorrectly.

Some of the participants marked which drink they liked best. It was interesting to see how many liked Coke compared to Pepsi. But it was also interesting because sometimes they said they liked Coke better, but they chose Pepsi because they did not pick the right cola in the blind test. Below is the cha rt that shows out of the 19 people that listed their favorite, that 13/19 preferred Coke and only 6/19 Pepsi.

The importance of this experiment to see if there a different between the cola and if one sells better than the other . It is also interesting to determine if people prefer a brand due to marketing and not actual taste.

What Type of Seed Do Local Birds Prefer?

Ian Fuls

I conducted this experiment to find out which type of seed local birds prefer. Every day for ten days I had bird feeders outside in my backyard with four different types of seed. Once 24 hours had passed I would bring the bird feeders inside to measure the mass of the seed inside of the feeder. The feeders would then be put back on the shepherd's hooks to be observed until another 24 hour cycle passes. Over the data collection, I started to see that the feeder containing peanuts was starting to get noticed more. The feeder with sunflower seeds always had a few birds eat at the feeder. The other two feeders were practically never eaten from. Since the consumption of peanuts was showing a trend, they were undoubtedly the most consumed seed on average. The outcome of this experiment was very surprising to me. I hypothesized that sunflower seeds were going to be consumed the most, but the data showed that peanuts were instead consumed the most.

A Hamster's Preference: Which Food Will it Pick?

Kaitlin Telep

The question that I attempted to answer was, “Will a hamster prefer a vegetable, grain, or fruit?” For this experiment you will need to, get a cardboard box and measure and cut out three holes the sizes of a cardboard tube. Place the tubes into the holes cut into the box and apply plastic wrap to the ends of them. Next, place plastic rubber bands onto the plastic wrap on the tube. This will secure the smells of each food. Show and let your hamster get an idea of what each food is. Place your hamster in the box, let it choose which tube to go to, and mark down which food your hamster goes to each time. Time how long it takes your hamster to go down each tube. After completing one trial, move the tube with the food in it to a different hole to make sure your hamster does not repeatedly go to the same area in each trial. Repeat this process fourteen times. I found that my hamster preferred the vegetable, cucumber, choosing it eight out of the fourteen trials. Banana was chosen five times and bread was chosen one time. Banana had the lowest average time recorded of 9.82, cucumber had an average time of 15.33, and bread had the highest average time of 28.96. In conclusion, my hamster preferred a vegetable over a fruit and a grain.

Do Dogs have a Color Preference?

Joseph Doebler

Abstract
The experiment that I performed was Do Dogs have a Color Preference. I performed this experiment because since I was a little kid I have wondered if my dogs had a favorite color like people. To begin this experiment I placed a green,blue,orange,yellow and purple piece of construction paper against a wall at an angle. The reasoning for placing the paper at an angle against the wall is for the next step. The next step is to place a dog treat behind each piece of construction paper. Next I let one of the dogs come and examine the pieces of construction paper then I recorded what piece of paper the dog took the treat from or knocked over first. After this I put my dog in a separate room and changed the order of the construction paper. The reason for changing the order of construction paper is so I could figure out if my dog was going to a specific color or spot. The finale step that I performed was repeating this process ten times with my three dogs so I would have the most eligible data as possible. Because I have performed this experiment I have found that the color yellow was examined the most by the dogs the color green was examined the second most the next most examend where purple and orange those colors tied and the least examined was blue.

Reptile Recovery: How local actions can protect endangered species

Shreya Sekar

Minnesota is home to 29 species of reptiles, of which two are endangered and 19 listed as least concern. Threatened reptile populations depend on actions taken by municipalities during community growth and construction to protect their habitat and steady their populations. This project is very important because people need to know what municipalities might be doing to protect reptiles, and municipalities need to be informed about policies they can adopt and other actions they can take to save these creatures.

I have reviewed municipal web pages for all 87 counties in Minnesota, looking for any available reptile policy information. None of the counties have policies listed. Additionally, I have contacted administrators at all 87 counties to ask if they are in discussion about upcoming policies or interested in learning more about potential policies. To-date, the response rates from local administrators have been low. None have discussed impending policies, but some are evaluating local management practices.

I have confirmed my hypothesis that municipalities in Minnesota do not yet have specific policies for reptiles. Certain municipalities have asked for information on what they can enforce as policies so my next steps include providing them that information. I will also continue to engage with DNR staff on best management practices that communities can choose to apply. With this project we can build awareness on reptile and turtle policies. Minnesota is well-known for its natural resources, and this project demonstrates that options exist for humans and reptiles to coexist in harmony.

Does Your Sight Deceive?

Francesca Chastek

The Effects of Artificial Food Colors on the Release of Neurotransmitters within Model Organisms

Ahlaam Abdulwali

This paper studies the effect of artificial food colors on the release of the neurotransmitters serotonin and dopamine . The model organism being tested on is the crayfish; which will be separated into four different groups. The control group will not receive any additional food dyes in their food and the three different variable groups will each have a certain food dye incorporated into their diets. The first variable group will receive Blue 1, the second variable group will receive Yellow 5, and the third variable group will receive Red 40. The protocol that will quantify the change in serotonin and dopamine levels is HPLC with Mass Spectrometry; which will require tissue cells from crayfish that will be extracted on a two week basis in order to examine a change. The objective of this study is to quantify a change in dopamine or serotonin levels when a model organism is exposed to artificial food color to eventually connect artificial food color consumption and the prevalence of mental illnesses.

Fruit Fly Frenzy: Investigating the Development of Insecticide Resistance in Drosophila Melanogaster

Fiona Kinney

Simren Samba

The United States uses over one billion pounds of insecticides annually due to an estimated 37% of pest derived destruction in the potential crop yield of North America. However, as problems of insecticide resistance in pests becomes more prevalent, farmers increase their use of these chemicals which can detrimentally affect non-target species. Thus, understanding how insecticides affect pests and how resistance develops is crucial.

Our study tested two insecticides with different mechanisms of action: an insect growth regulator (IGR) called Methoprene and a directly toxic insecticide called Permethrin. Permethrin affects insects by attacking their nerve and muscle systems and directly causes mortality, while IGRs cause a change in the growth cycle of the insect, inhibiting the flies from fully maturing.

Groups of fruit flies were exposed to Methoprene or Permethrin using media made with chemical doses that were experimentally determined to affect 50% of the fly population. After reproduction, the second generation was exposed and, in the case of Permethrin, a third and fourth generation. After the second generation of exposures, the mortality rate of flies exposed to Permethrin essentially equaled the control mortality rate. Resistance developed rapidly against Permethrin, while the resistance never developed against Methoprene, and these flies died out after two generations. Our results suggest that choosing toxins that modulate reproduction rather than directly killing insects might be a better choice to slow the development of resistance.

Significant zero: the effect of personality questionnaires on identity-relevant choices

Naci Konar-Steenberg

The purpose of this project was to see if taking a Big Five personality test or making decisions about choices between pieces of media could act as a method of identity priming. Two experimental groups each took a personality test and answered a list of questions about their choices in media, in different orders. Control groups took only one test or the other. The study was conducted on Amazon Mechanical Turk. The group that took the personality test first had significantly higher variation in answers ($p = 0.006728$). There was no significant difference in variation in the group that took the media choices test first ($p > 0.05$), although one factor, Openness, approached significance ($p = 0.052815$). The hypothesis was accepted for the group that took the personality test first and rejected for the group that took the media choices test first. This is likely due to the act of taking a personality test causing respondents to consider their identity more heavily in the media choices test.

Videos and Heart Rate

Selamawit Tenaye

I was interested in how scary movies affect your Heart Rate, because I saw one person fainted while watching a horror film. People might be interested in this experiment as well because they want to know how they were affected by scary movies . I decide to test about(videos and heart rate) because I really wanted to learn a lot about heart rate and now I know how scary movies affect your Heart Rate. I Measured the participant's Heart Rate using the oximeter while sitting down . Then I recorded the participant's Heart Rate (bpm). Then I showed the scary movie to my participant's (https://m.youtube.com/watch?v). Then I took the participant's heart rate using the oximeter (bpm). Then I recorded the participant's Heart Rate (bpm). I repeated the steps (3 times) with new participant's. After collecting my data, I graphed my results and found that scary movies affect most people's heart rate. When we see our participants heart rate, before watching the scary video their heart rate was at 79.3(bpm) but after watching the scary video their heart was at 92(bpm). I learned that scary movies can affect your heart rate.

Can you tell if someone is lying based on how their body language changes?

Leah Neil

The purpose of my experiment was to find out if people can detect if others are lying based on their body language or facial expressions. I became interested in this topic when I started researching neuroscience science fair topics. I have always been interested in neuroscience due to my dad working at a neurology clinic. I came across a topic that was more focused on pupil size changing when lying. I was inspired instantly. I kept researching and found an abundance of sources not only on pupil size changing but overall body language changing. For my experiment, I asked test subjects to tell me two lies and two truths. I recorded their reactions of body language to detect if they were lying. After stating all the truths and lies, I determined which ones were truths or lies based on the body language information I recorded.

Do Children Who Read More Have Better Vocabularies?

Audrey Erickson

In my experiment, I tested whether children who read more, (100+ minutes a week), or children who read less, (less than 100 minutes a week), had better vocabularies. This experiment's purpose was to assist parents who wanted to expand their child's vocabulary, and inform them whether having a child read more or read a certain type of book had an effect on vocabulary level. To perform my experiment, I tested 56 different subjects on their vocabulary level, and asked them how many minutes they read in a week, their preferred book type, (chapter books or graphic novels), and their gender. When I added the results up, I observed that subjects who read more and/or preferred to read chapter books scored a slightly higher average than those who read less and/or preferred to read graphic novels. Although subjects who read more scored higher than subjects who read less, the gap between the averages was not substantial enough for me to confidently say that children who read more have better vocabularies. Additionally, there are dozens of factors that are unaccounted for that could have interfered with the results of the experiment. Technically, my hypothesis is correct, but not reliable. Hopefully, someday I will be able to redo this experiment professionally, with thousands of subjects and all factors accounted for.

How Does Age Affect Your Memory?

Noelle Akins

The purpose of my experiment was to see if age has an effect on memory. Memory is a very important part of everyone's daily life. Concern over memory loss is an active and evolving part of the aging process. I wanted to do this experiment because my grandmother recently passed away due to Alzheimer's. This loss sparked a lot of questions in my mind about memories. For my experiment, I told my test subjects five different words and repeated them twice. After the words, I asked the subjects a series of questions to distract them from the words I had recited to them. After completing the questions, I asked the test subjects to repeat the five words back to me in any order while I timed them. Once they repeated all the words back to me, or their time ran out, I scored them on a scale of one to eight based upon the number of words recalled and the amount of time it took (the scoring process is documented in the experiment section of my paper). Upon review of my results, I determined middle aged people (ages 26-60) can remember things more easily than people in other age ranges. My results led me to infer that middle-aged people may be at peak brain development, they are highly active in multitasking, may be able to maintain attention and focus better, and a few of my test subjects developed a process of remembering the given words.

How Does Cell Phone Usage Affect Reaction Time?

Ben OShaughnessy

Distracted driving is an important issue around the world, with over 30,000 injured yearly just in the United States. The purpose of my experiment was to find out how cell phones affect reaction time , in both texting and calling. If drivers are educated about how much their focus and reaction time is affected by distraction , they would possibly be motivated to use their cell phone less in the car. I tested subjects by taking their reaction times in both a texting conversation and call. My data found that texting raised the reaction time the most. I think this is because the subject loses focus on the reaction time test when they are texting or calling.

If Someone Smiles At You, Will You Smile Back?

Jane Stangler

For my science fair project, I wanted to see how people would react if I smiled at them. In this test, it was critical that I made eye contact with all the people I smiled at. I did this experiment because I wanted to test if smiling was “contagious”. I know that smiling makes people happier, healthier, and more productive, so if I’m feeling happy, why not try to pass on the good vibe? My experiment is important because my data shows that if you smile at someone a little more than 90% of people will respond positively. Imagine how positive and upbeat the world would be if everyone smiled at just one person per day. I conducted my experiment by going around my school community, making eye contact and smiling at people. Once I smiled, I paid close attention to the subject's reaction. I smiled at 33 people and 45% smiled back, 15% said hi, 30% had another positive reaction, and only 9% had no reaction. I think my results turned out this way because according to the Aultman Health Foundation, humans are “behaviorally and psychologically conditioned to return the favor.” In the end, I found that 90% of people that I smiled at responded positively.

Smell vs. Taste

Quinn Walsh

Samantha Palm

We were interested in this because we wanted to see how much smell actually affects taste, and what happens when your sense of smell is different than what your tasting. Then we decided to use Starbursts because they have all the same texture, yet different tastes. In the experiment we decided to test on one specific age group and gender because we were unsure if age or gender would affect our experiment. To ensure that every test was fair we always used the same scent with the same flavor. Our data showed that almost 60% more people got the taste correct when not smelling a different scent. In conclusion, we learned from our data that more people could taste the flavor of what they were tasting better when they were not smelling something which proves our hypothesis that smell does affect taste.

Maple Syrup Candy

Morgan Johnson

We were interested in finding out if age affects your taste preferences. We thought others would be interested in it because our results could help people find food that everyone in the family will eat and enjoy. We decided to test whether people would prefer regular or organic maple syrup candies. For the procedure, we made maple syrup candies with regular maple syrup, then with organic. We made sure it was a fair test by making sure to test at least four people in our four age groups. Our data shows us that in our six and under category, it was tied, two to two. Seven through ten, three people preferred pure maple syrup and two preferred organic. In eleven through thirteen, two people preferred pure and three preferred organic. For fourteen and up, two preferred pure and three preferred organic. We found out that younger people prefer regular maple syrup over organic. After we tasted it, we found out regular maple syrup was sweeter than organic maple syrup. Over all, more people preferring organic, with ten people preferring it, and regular with nine people preferring it.

Music and Test Performance

Elijah Moen Grear

Molly King

The purpose of this experiment was to find out if music affects concentration on work or something like math , homework or both. We were interested in this because we both love listening to music while doing our work , and we wanted to know if it affected how fast and accurate we do our work . When doing tests especially with humans, you have to make sure it's a fair test, so we decided to use 7th grade boys for our tests, and we gave them a packet of multiplication problems/logic skilled problems. We made sure to test them first with music without lyrics (specifically "Nighttime Ramen", Chillhop Music, YouTube), with music with lyrics (specifically "Revenge", by Captainsparklez Minecraft parody, YouTube) and finally without music. We learned that music with lyrics does the worst , but no music and music without lyrics were practically tied, yet no music unfortunately prevailed. We learned that music with music doesn't help and that no music , and music without lyrics are almost the same when it comes to accuracy.

Pandemic Pragmatism: The impact of COVID-19 on sustainable living

Ahreum Ham

The COVID-19 pandemic has caused people to quickly re-adjust to working and learning from home. Many had to change their lifestyles to live sustainably, affecting their energy usage, financial spending, travel, and food consumption. While implementing these changes, many people became more aware of sustainability, the benefits of which may continue to be valuable after the “normalcy” returns. This research project focuses on analyzing choices people have made while adjusting to a stay-at-home lifestyle.

A Google survey was developed asking volunteer participants to respond to questions in nine topic areas , reflecting on changes within the household over the past year.

Responses received show that since the onset of the pandemic:
76% reported increased awareness surrounding sustainability,
45% experienced increased residential energy usage,
-74% traveled less than normal over the six major holidays in 2020,
-73% increased the number of meals made at home, with 60% giving more thought to nutrition and wellness,
-48% of respondents, or immediate family members, experienced unemployment resulting from COVID-19, and another 12% saw reduced hours and pay.
-62% of households decreased spending,
-65% reported increased outdoor recreation,
-23% did not participate in routine medical care since the onset of the pandemic though they did prior, and
-33% shop local food cooperatives, which is unchanged.

These responses reflect that household habits can change quickly, and some could be maintained in the future, regardless of stay-at-home orders. Transformative events are opportunities for people to reevaluate their habits and adopt practices that are more sustainable.

Harnessing Innovation in Healthcare: Solving Disparities and Inequities in Minnesota's Healthcare Services Using Creative Solutions Proposed by Medical Providers

Holly Restad

Access to quality healthcare is vital for maintaining health and equity in Minnesota. However, healthcare is not equally accessible to all residents, with stark differences in healthcare delivery based on location, medical resources, staff availability, and internet access. This research study aimed to gather input from healthcare workers on the delivery of healthcare in Minnesota and to compile innovative solutions to help reduce these inequities.

In order to gather many perspectives, an online survey was created using Survey123 and distributed to a wide range of health care workers in Minnesota. The survey posed questions in five categories: employment status, job satisfaction, facility and equipment adequacy, regional patient population, and patient demographics to evaluate current inequities and creative solutions for the medical field. ArcGIS mapping technology was used to highlight factors that might contribute to the survey respondents' answers.

Study findings show a strong need for more:

● Work in reducing inequities in telehealth, as 1/5th of rural Minnesotans do not have reliable internet access, and

● Access to health insurance itself, as uninsured numbers are rising.

Changes arising from the economic challenges of the pandemic are adversely impacting job satisfaction, such as removing employer retirement matches, which will affect if healthcare professionals stay in the field or leave. Providers spoke of trying hard to meet the needs of patients and address the obvious health care delivery concerns, but still feeling it is not enough. While healthcare has come to the forefront of discussion, more needs to be done to propose innovative solutions.

Exercise: Virtual Reality vs. Physics

Orion Tyrrell

In the last year, the world was hit by a pandemic that disrupted traditional activity and exercise routines. As an alternative method to maintain physical health, Virtual Reality based exercise programs have become accessible within the last two years. I am analyzing fitness tracker data from the last year, collected by my dad, who uses VR fitness as one of his alternatives to running due to having fallen arches. I will be using beat saber and walking in my tests. I believe that Beat Saber will have more total calorie burn but walking will be far more consistent. I believe this because Beat Saber requires much faster movements than walking however, it uses a system of maps which stops the activity until the player begins another map. This is amplified by the fact that the player will be getting better and will have to use new and more difficult maps to achieve the same affect causing further inconsistency. Based on the collected data, Beat Saber is a much higher intensity workout, burning more calories per minute and showing a much higher average heart beat that walking / hiking. Beat Saber also displayed far more out of control points on individual and moving range control charts. This could be because of the varying length and intensity of the maps, or another assignable cause. It's worth noting that Beat Saber is primarily an upper body workout, while walking / hiking is a lower body (legs) workout. This could conceivably skew the calorie burn data for beat Saber.

Sibling Relationship

Valentina Penaloza

The purpose of this experiment was to determine if there was a relationship between having siblings and the personality of a person. Background information was collected, most of the previous experiments explain that having siblings can affect the personality of a person. The background information that was collected stated that older siblings are more neurotic and independent, middle siblings tend to be more emotionally stable and better at resolving conflicts on their own, finally, younger siblings tend to be more risk-takers and rebellious. The background information also states that younger siblings are better in social interactions and are more extroverted than their older siblings. To conduct this experiment two questionnaires were sent to volunteers. Questionnaire (A) tested the relationship between siblings and the difference in personalities and Questionnaire (B) tests the instantaneous change in the behavior of a child when a new sibling was brought home. The results of this experiment (Questionnaire A) agree with the background information based on the test. The results of the experiment stated that youger siblings. Thanks to the results of the experiment we can conclude that younger siblings have a tendency to be more extroverted than oldest siblings.

What Causes the Most Stress On Teenagers?

Eleri Deaven

Perception vs Reality

Elias DeCrans

The question that I have been trying to answer is, “Does a line affect a person's test taking performance.” In my procedure, First I set a desk up outside a classroom and set out a survey on the desk. I then went into the classrooms and took out groups of students. Then I told them to get in a line and take the survey. Then I would take the people's time to take the survey. The people with the line behind them I put in the line group and the people without people behind them I put their times in the no line group. I did this with multiple classes and after I pooled all the data and made graphs and other comparisons. In result I found that the people with a line behind them took the survey faster than the people with no line behind them. I found that the average time to take the survey with a line behind you is 38 seconds. I also found that the time without a line is 49 seconds. This supports my hypothesis that the people without a line took longer than the people with a line. I think this because the stress overwhelmed the participants and overall made them rush through the survey. In conclusion, I found that a line does affect your time for taking a survey. With a line you take the survey faster than without a line.

Ready, Set, Go; Does Age Affect Reaction Time?

Kacia Caron

The reason I wanted to do this project was because I wanted to do a project with human participants. I also wanted to learn more about age and reflexes and how they affect each other. This project seemed perfect for these requirements that I made for the project. The human participants did not need to do anything too hard for the reflex test. All they needed to do was go to the website online of my choice and go through it three times. The first two times were to get used to the test so they could get the most accurate results. The third time through the test was for the participants to get the most accurate data. The time they got on the third time through the test went into the form, along with their age. The form would then be sent to me. From this form I got all the data which I put into data tables. The data tables were then formed into graphs. The graphs showed me that as you get older your reflexes take longer to act. This data proved my hypothesis to be correct.

Were You Lied To?

Nathan Nguyen

The purpose of this experiment was to determine if I could detect another person if they were lying or not . For my procedures, ask the participants three things they like and three things they dislike. Once completed, ask the volunteer to repeat after you. Say the first thing they said they liked. For example, I love donuts. On completing the sentence, look at the heart rate detector and record the number you see. Then ask them the first thing they said they disliked. For example, I love vomiting. Again, look at the heart rate detector and record the number you see. Repeat these processes until you have six heart rate measures in total. I found that the younger a person is, the easier it is to detect a lie. A fifth grader had a heart rate of 102 beats per minute for their truth, and 111 beats per minute for their lie. This was a bigger number than needed to be considered a lie. An eighth grader got 68 beats per minute for their truth, and 62 beats per minute for their lie. This was not reasonable enough to be a lie since their lie heart rate decreased. An adult got 74 beats per minute for their truth and their lie. This showed to me that adults were not easy to detect a lie since this person's heart rate stayed constant . In conclusion, I found that you can detect a person lying, but is easier on younger people.

Top 5 Sleepy Activitiezzzzz

Michael Elfering

The purpose of this project was to find out what the most effective activity is to fall asleep . I want to know this because it would be helpful to know for people who have trouble sleeping. They are the people who need this information the most.
In this experiment, I and the other subjects did an activity for 30 min, then put on watches that tracked sleep. Then we recorded the data into a google form. I did not get many subjects that gave me data, so that may have affected the results. Exercise had an average of 0 min, movie had an average of 3, nothing had an average of 7, and so did reading, and TV had an average of 1 min. These results are likely invalid because I only had 12 data points in total.
According to my data, if you want to fall asleep and multitask, exercise. I understand if this conclusion is proven wrong because I understand I did not have enough data points.

Does Your Zodiac Sign Predict Your Personality Type?

Eleanora Kucko

The purpose of this project was to answer the question, “Does your Zodiac Sign Predict your Personality Type". More specifically, I was trying to investigate if there are any correlations between zodiac signs and personality types. First thing I did was getting human participants to take a personality quiz that is an edited version of the Myers- Briggs Type Indicator. I had them take the test and then insert their results into a form along with their birthdate. Then I took all of the information that was gathered and put the participants into their correct zodiac sign group. I took that information and put it into a sheet. Within the sheet I created my graphs and data tables that had all the information that summarized the data. The graphs and data allowed me to have a greater insight on my information.
In my data I found that the category that I thought would have the most correlation with zodiac signs, Extraversion/Introversion, showed to have the least amount of correlation. On the other hand, the category that I thought would have the least amount of correlation, Feeling/Thinking, showed to have the most correlation. In conclusion I found that in some sense zodiac signs can have an affect on personality. However, I think that in my data I did not have enough information to get an accurate claim on this topic.

How Does Music Affect Your Mood?

Ashley Vega

The purpose for my experiment was to find out how music affects someone's mood. My procedure was to sit the human participants down, take their heart rate without any music playing and have them take a mood survey before doing anything. Then play each song and after take their heart rate and have them take the mood survey again. Repeat this for as many categories of music you have. I found that happy, loud, up-beat, and quicker tempo music made people more cheerful. Slow, quiet music made people less pleased. When someone feels happy their heart rate decreases, and when someone is sad or angry, their heart rate increases. While comparing the music to their mood survey to their heart rate, most people's heart rates decreased with the louder, faster music. Some of the people I tested did end up having some different result, like some people had both their heart rate increase and/or decrease with each emotion, happy or sad. This could have been due to stress, or other errors that occurred, human or machine. In conclusion the faster paced music made people represent more positive emotions and slower, quieter music caused people to feel unpleased, or sad with the music displayed.

How Does Color Affect Your Memory?

Kayla Miller

My question of my experiment explores the effect of color on memory. The purpose of this experiment is to improve studying habits, improve attention, and to improve memory performance on people with memory disabilities. In my experiment the participants were given a story to read for a total of two and a half minutes. Their stories all had text that was highlighted in pink, yellow, dark grey, blue, or no color. After they read the story they were given a quiz that had questions about the test. The quiz included a question that asked you to state your color group.

I found that, as I predicted, color does affect memory. More specifically, I found that yellow is the color that causes an increase in memory performance the most. The results were close but I did find a significant difference in the effect of color and no color. In order of most increase of memory, to least increase in memory, it was yellow, dark grey, pink, blue and then no color. In my experiment, there was a score that could've messed up my experiment. There was a low score in the yellow group even though the rest were very high scores. This ended up okay, but yellow was not as high of a score.

In conclusion, I found that color does increase memory performance and more specifically, yellow increases memory the most. My data did support my hypothesis. I hope that my results will be used to increase memory performance.

How Does Food Affect Taste and Thoughts?

Christopher Sosa Escobar

The purpose of my experiment is how food can be detected without being tasted. I included food because I wanted to know how other people could be affected by food. Another purpose is for people can't be tricked into buying a burger that looks delicious but tastes disgusting, they can be tricked by the way the food looks. The subject will be given either takis or gummy bears and a piece of paper that includes 3 questions, the subjects will have to answer. In total 53 people participated but 3 weren't included, 10 subjects got affected and 13 did not get affected by the gummy bears. 9 subjects got affected and 18 did not get affected by the takis. This means that less people got affected by the food and more people didn't. In conclusion people can be affected by food because you put all these ideas in your head about what you think your food would taste like, when you taste it, it tastes the same or doesn't taste the same as you thought. If you got your thoughts wrong then you got affected but if you didn't then you weren't affected. This goes with my hypothesis which pretty much says the same, but food can affect you on what you think the certain food would taste like, so we have to be careful on what you/we eat.

How Do gender and Marketing stereotypes affect color preference?

Shannon Reilly

When you compare many products made for girls and products made primarily for boys you may notice a difference in the colors of the products. Is this because of color preference or do the products create the color preference? Many people who I speak to main females feel a strong sense of gender stereotyping around color and products and clothing. I choose to do this project because of the stereotypes in marketing and in everyday life to see how much of an impact it has on views towards something as simple as favorite color (positive or negative). I feel like it is important to show how marketing and stereotypes can be harmful to the way we think.

Facts vs Anecdotes and how they persuade

Camille Witherspoon

Corinne Moran

Elin Wellmann

This study attempts to answer the question, "Are facts or stories more effective at changing a person's current belief"? The use of genetically modified organisms is a highly debated topic that many people have prior beliefs about. Students were selected for the study if they did not believe in the use of genetically modified organisms. They were divided into two groups, the first group was asked to watch video segments of a ted talk supporting the use of GMOs, the second group was given written statements from the same video segments. The percentage of each student's beliefs that were changed from watching the videos were compared to those whose minds were changed from reading the statements.

Mixed people in violation of race: can mixed people debunk the race myth?

Lena Pak

Mixed race people have a unique perspective because they belong to multiple racial groups and violate the social definition of race. To provide more insight on the mixed perspective, this research aims to identify differences between mixed people's internal identity and the way society classifies them. The hypothesis is cultural connection (language fluency, food, friends, etc) will have a stronger impact than phenotype on racial identity development, and internal identity will not be strongly correlated with society's classification of them. The hypothesis will be tested by interviewing mixed volunteers to determine if cultural connection or phenotype has a stronger impact on identity development. Then a survey distributed to a sample of the general population will expose how society classifies the mixed participants, and participants' internal identity vs. social classification will be compared. Showing that racial identity does not correlate with "race," it can debunk the race myth and minimal racism.

The effects of Tamarkoz (R) meditation on adolescents aged 15-18

Mahdi Khamseh

Learning in the Living Room: What Skills Contribute to Success in Distance Learning?

Nathan DeMichaelis

Hybrid learning is a combination of face-to-face learning and online learning that many schools have adopted to allow in-person interactions in socially-distanced classrooms. Independent learning is inherent in distance learning, such as hybrid learning, and requires students to self-regulate their studying. Evidence suggests university students lack adequate skills and attitudes for the most effective studying. Because high school students are less developed in their cognition and study ability, these shortcomings could be worse for them. However, there is a lack of studies on high school students' self-regulated studying during distance learning. The purpose of this study was to identify factors related to studying that play significant roles in students' outcomes during distance learning.

A cohort of students in a hybrid learning model completed the Learning and Study Strategies Inventory for Learning Online (LLO), a questionnaire that measures students' abilities and use of study strategies as well as their attitudes towards studying. Next, these students completed weekly surveys on their studying, including methods and timing, and grades.

The average time studying did not significantly correlate with grades, nor with any items measured by the LLO. Selecting Main Ideas, Test Strategies, and Concentration were found to be the most significantly correlated variables with grades. A significant difference was also found between groups separated by Test Strategies score in the use of science-backed test methods proportional to less effective methods. These findings point to areas that educators should focus on to improve students' study habits, especially for distance learning.

Assessment of Post-Injury Mental Health and Analysis of Emotions

Owen Murphy

The purpose of this study is to identify and assess depressive symptoms in athletes post-injury. It is important for people to know this information because, as an athlete, athletes tend to hide their feelings both physically and mentally. They want to get back to practice and into the games as quickly as they can, generally with little regard for their own health. This research has the potential to help athletes and their families identify negative emotional symptoms, and to allow a proper amount of time for both physical and mental recovery. This research uses a survey to identify the symptoms, good or bad, in athletes and the short/long term effects that these symptoms can have on the athlete. Firstly, data will be collected from the students at Minnetonka High School, then, it will be synthesized, analyzed and conclusions about depressive symptoms and treatments will be formed. As the research progresses, more refined surveys will be sent to athletic departments at larger institutions in hopes of gathering a lot of data to help produce more accurate conclusions.

Investigating the effect of the severity of activity based anorexia in Drosophila melanogaster on the gut microbiome

Peyton Crest

Anorexia Nervosa (AN) is a psychiatric illness characterized by deliberate restriction of caloric intake, which can result in a slowed metabolic rate, hyperactivity, and dysbiosis of the endocrine system and gut microbiota (Lucas et al., 2020). In order to model the effects of AN, Activity Based Anorexia (ABA) is a bio-behavioral phenomenon used in model organisms (Chowdhury et al., 2015). Previous research has examined the effect of ABA on the gut microbiome in model organisms, yet no research has examined how the severity of ABA affects the gut microbiome. In order to effectively model ABA, the caloric intake of D. melanogaster will be reduced by restricting the amount of yeast and exercise will be induced using a Power Tower, which utilizes geotaxis methods. The severity of ABA will be increased among randomly selected D. melanogaster by increased restriction of caloric intake and induced exercise. The gut microbiome will then be analyzed using 16 s rRNA sequencing to determine how the severity of ABA influenced the composition of the gut microbiome in D. melanogaster. If the hypotheses are supported, further research will apply the findings to humans and aid in potential criteria for the diagnosis of the severity AN in humans.

Predicting compensatory exercise behaviors from anxiety symptomatology in patients with eating disorders: secondary analysis of a publicly available dataset

Abirami Rajasekaran

Harini Senthilkumar

Eating disorders have taken a mental toll on today's adolescent and young adult population . Previous studies have indicated associations between internalizing symptomatology (such as anxiety, depression, and eating disorders) and compulsive exercise. Also identified as compensatory exercise, this behavior is characterized by increasing exercise amounts, withdrawal symptoms, tolerance, and loss of control. It is unknown how eating disorders will affect the comorbidity of internalizing conditions and compensatory exercise.

This study uses deidentified public dataset from a repository of completed mental health clinical trials available for secondary predictive analysis methods using R statistical software to classify correlations and risk factors with compensatory exercise. The baseline data is an ongoing dissonance-based treatment for 156 young adult female patients (Mean age = 22.33 ± 3.75 years) representing a range of eating disorders and sub-threshold eating symptoms and associated diagnostic questionnaires. We performed descriptive statistics to develop our statistical model to test the hypothesis that anxiety increases risk of compensatory exercise.

To test the hypothesis, a zero-inflated Poisson (ZIP) model was used to predict frequency of compensatory exercise behavior based on anxiety scores, controlling for eating disorder symptoms and diagnoses. Results indicated that compensatory exercise has a negative relationship with anxiety, while compensatory exercise has a positive relationship with eating disorders. Results could inform clinical practice by determining treatments specific to the patient, rather than the diagnosis.

Saving Lives Through Legislation: Addressing Gaps in Coverage for Breast Cancer Screening

Tori Thomas

Diagnosed in 13% of American women, breast cancer is a significant national health concern. Thankfully, mortality rates have declined across the United States, in part due to increased screening through routine mammograms. Unfortunately, access to screening is not universal, adversely affecting younger women and those for whom the cost of screening is prohibitive.

It is recommended that preventative breast cancer screenings begin at age 45-50, or earlier if deemed “high risk.” Diagnostic screening is then used if something abnormal appears on the preventative scan or symptoms present themselves. Minnesota Statutes clearly stipulate scenarios for insurance coverage. Unfortunately, thousands of women do not meet this strict criteria.

The goal of this project was to characterize breast cancer screening, diagnosis, treatment, cost, and patient outcomes, then examine Minnesota law, document coverage needs, detail gaps, and propose solutions. Women who are pregnant, breastfeeding, have recently experienced a miscarriage, or are going through IVF are not uniformly covered for this critical screening tool. Access to insurance coverage for ultrasound, MRI, and diagnostic screening when a woman’s circumstances necessitate it is challenging. Cost analysis shows the screening tools are inexpensive compared to treatment costs, demonstrating expanded insurance coverage that achieves early detection is less expensive than the current approach.

I propose the solution to this problem is to draft legislation to address gaps in coverage, and have created language for consideration by the 2021 Legislature, which is currently under review by a group of Legislators. The outcome could successfully save both money and lives.

Defeating the Divide: Creating sustainable partnerships in global healthcare between academic institutions and the communities they serve

Lily Nothom

Efforts in global healthcare have strategized how to effectively combat COVID-19. During the beginning stages of the spread of COVID-19, effective strategies by global healthcare partnerships to isolate the virus were scarce. Only after the virus spread globally did efforts to coordinate and isolate commence. The magnitude of the pandemic and the irreversible change it has caused were preventable had effective and sustainable global healthcare partnerships been in place with emphasis on community work. The purpose of this project is to gather innovative ideas and strategies to strengthen current global health partnerships from academics with experience in global health education through a survey. .

Phase 1 of this research considers how survey development should be best optimized to academics spanning five continents because of the diverse situations in those institutions. The study author developed the survey with the three stages of physician training as the central idea for the survey. It was determined that having participants evaluate these separate sections of their academic institutions would allow for more in-depth analysis and this would lead to more detailed ideas for innovation. The survey was drafted with a focus on questions that would prompt qualitative answers and data, and will be distributed through the RedCAP software.

This is an ongoing project and results from global survey participants are pending. Once data collection is complete, the delphi methodology will be used where certain consensuses from the data will be distributed and observations on whether or not other participants agree will take place.

Comparison of educational success between high affiliation-need and high autonomy-need students in an online learning environment.

Emil Liden

The purpose of this study is to compare the educational success of high affiliation-need and high autonomy-need students in an online learning environment. With over 1.2 billion students worldwide, this study is important because it allows for an in depth analysis of the reasons why some students may be struggling in an online learning environment. In previous studies, high affiliation-need students were shown to be less likely to take online courses than high autonomy-need students. This evidence suggests that since high affiliation-need students do not prefer online learning, they will be less likely to succeed in such an environment than high autonomy-need students. This, precisely, is the proposed hypothesis of this research study. In order to test this hypothesis, data will be collected using student-response surveys that contain questions relating to students' success during online learning. Each set of questions will be analyzed individually and the responses of high affiliation-need and high autonomy-need students will be compared.

Change, Opportunity, Vision, Innovation, and Decision-making (COVID): Business and Personal Strategies for Surviving a Global Pandemic

Lorien Zhao

The COVID-19 pandemic has had far reaching consequences on society. By January 2021, 25.3 million Americans had tested positive for COVID-19, and over 423,500 were killed. Almost all businesses have had to change employee practices to ensure safety and have seen changes in their interactions with consumers. Because this situation is unprecedented, there is a lack of predictive insight to how businesses and individuals will respond. Thus, the three specific aims of this project were to:

- Characterize the effect of COVID-19 on the success of U.S.-based businesses,
- Investigate the similarities, if any, between past crises and the COVID-19 crisis, and
- Determine how the responses of business professionals relate to and differ from the general American population .

The author developed four quarterly surveys to evaluate business and private citizen responses over the course of a year. There were two different types of surveys created each quarter: one for those involved in the business sector and one for everyone else in the general population.

Results demonstrate that businesses were able to adapt to their new situation by changing their operation's costs and how they offer their products and services. Additionally, results indicate that Americans are generally more anxious because of COVID-19 and are more willing to give up personal freedoms, which is similar to how they responded to past crises such as war. Lastly, results illustrate that business professionals are not completely homogenous with the general American population due to different opinions on public policy.

More than Just a Runner's High: Single-bout exercise and its lasting effects on cognition in the brain

Greta Goldade

Anaerobic stimulation has been shown to activate the frontoparietal network, the same network that is used when doing math and reading. The correlation between the stimulation in brain networks has led neuroscientists to believe that exercise could boost cognition and, by parallel, standardized test scores. More specifically neuroscientists looked into the effects of single-bout exercise due to its relation to PE classes in school. The results concluded that there was in fact a boost in cognition, however, there has been speculation as to how long this increase lasts. The purpose of this study was to answer the question, “When is the best time after anaerobic exercise to receive maximal cognitive benefits?”

To test this question, high school students took a baseline test consisting of 25 questions from a medium level math section. Following this test, participants engaged in 20 minutes of anaerobic exercise (HR of 140 or higher). Proceeding exercise, participants were randomly placed into one of three groups, taking a second SAT test either right after exercise, twenty minutes after exercise, or an hour after exercise. Students' results will compare their final score relative to their previous score and then to each other.

This work holds the potential to ascertain the exact effects single-bout exercise has on the brain and how long it lasts. With this new knowledge, educators can better plan the school day to maximize student learning.

Women and Women of Color in College Coaching: A Quantitative Report on Head Coach Composition and Turnover for NCAA Division I Soccer.

Ramira Ambrose

Women are underrepresented in college coaching positions and leadership. Since the passing of Title IX, athletic participation for girls and women has increased dramatically, however, the opposite is true for women in coaching. In 1974, 90%+ of college female athletes were coached by women, but today the number has fallen tremendously to around 43% (Acosta & Carpenter, 2012). Additionally, women of color coaches' double minority status is often overlooked and marginalized as an underrepresented social group because they are frequently categorized with larger social groups such as "women" or "people of color." The purpose of this report is to examine the inclusion of women and women of color head coaches in NCAA Division-I women's soccer athletic programs within the Power Five Conferences during the 2020-2021 academic school year. The researcher assesses gender and racial diversity for each of the five conferences for the percentage of women and women of color by assigning grades. This report also investigates the occupational turnover of Division-I soccer head coaches within the Power Five Conferences from 2012 to 2021 by evaluating the gender, race, and winning percentage of the outgoing coach in relation to the gender and race of the incoming coach.

Inside the Mind: Studying the Effect of Daily Tasks on Short Term Memory

Sanjana Kollipara

Do Different Oder's Move Your Motor

Annelli Hagen

Abstract section
Have you ever taken a test and wondered if the smell of your environment has an impact on your grade? I know I have! Therefore, I decided to test what smells affect cognitive alertness. I am going to test multiple children from the ages of 6-14. They will be taking multiple different additional tests. While they are testing they will be smelling one of the following items smelling salts/ammonia, peppermint, and lavender essential oils. periodically during the tests they will sniff an item. My hypothesis is that when my test subjects smell different smells during cognitive testing, they will perform best when they inhale ammonia.
The tests I created included a few addition tests and while they performed the addition tests the participants. I did run into a few problems while I was testing. First of all I had some participants getting distracted by what was happening in the surroundings and also people were looking at other people's papers. Overall I did not experience many hardships while I was experimenting.
The data I recorded was that 17% of the people did best with smelling salts 14% did best with lavender 15% did best with peppermint and 57% did best with no scents at all. I averaged out the results and ranked them by how many people out of the 14 benefited and did not from each scent. My conclusion is that most people from grades 1-8 do best with no scents at all.

Optical Illusions: Are You Just Bad at Seeing Them or are Other Ages and Genders Just Better

Kelsey Nelson

Have you ever wondered why some people can figure out what is happening in an optical illusion faster than you can? If you have, then you've come to the right place. In my science fair project I tested to see if different ages and genders can see optical illusions faster. My hypothesis is that women in their 30's will be able to see optical illusions fastest.

In my science fair experiment, I created tests to find out if different genders or ages see things faster in optical illusions. I tested the following age groups: 3rd graders, 7th graders, 30-40 year olds, and 60-70 year olds. I tested two males and two females from each group. The illusions I showed them were The Duck and the Rabbit Illusion, the My Wife and My Mother-in-Law Illusion, and The Faces and the Vase Illusion. I did have one unexpected problem when I was testing a participant through a FaceTime. The participant informed me after seeing the optical illusions that she had not been able to see the whole illusion, if she had been able to see the whole illusion she said that she would have seen it faster.

In my science fair experiment I tested my participants through how many seconds it took them to see the optical illusion. 7th grade females saw two of the three optical illusions I tested the fastest, while in the other optical illusion the females that are 30-40 years old and the females that are 60-70 years old tied for speed. Each female saw two pictures in The Duck and the Rabbit Illusion in about 16.375 seconds. Each male saw the two pictures in The Duck and the Rabbit Illusion in about 28.5 seconds. For the My Wife and My Mother-in-Law Illusion, females saw both pictures in it in an average of about 55.75 seconds. The males saw the two pictures in the My Wife and My Mother-in-Law Illusion in an average of 58.75. In the The Faces and the Vase Illusion, females saw both pictures in it in an average of 11.375 seconds. The males saw the two pictures in The Faces and the Vase Illusion in an average of 13.125 seconds. My conclusion is that females in 7th grade are the best at seeing optical illusions and that, overall, females are best at seeing optical illusions in comparison to men.

Does Adding Different Kinds of Yeasts to a Wort Affect the Overall Gravity of the Solution

James Summers

The purpose of my experiment was to test the efficiency of different strains of yeast. I became interested in this topic because my Uncle Tom Sullivan has been a homebrewer for a long time and used to take me shopping for malts and we would brew together. For my experiment I tested five different yeast varieties in the same wort, divided into five different containers. I had one container left open for natural yeasts, one closed so no natural yeast could get in, a WLP002 Dry English Ale, a WLP007 English Ale, and a WLP830 German Lager. I found the WLP002 Dry English Ale was the most efficient in the week-long fermentation period, with the WLP830 German Lager Yeast being a close second. I believe that this is because the WLP830 German Lager Yeast produces best under a colder environment, and this was proved because the Lager solution's temperature was always highest on the coldest days. It was expected that the Dry English Ale would be the most efficient, as my interview stated, it would be better than the other Ale Yeasts and since it was working with a Ale Malt, it was anticipated to be the most efficient.

Concluding if Denser fruits and vegetables contain more vitamin C

Bitaniya Zewde

Comparison of the indole and ammonia detection methods of E. coli and creation of a streamlined testing process

Madison Andrews

Escherichia coli, commonly known as E. coli, is a normally harmless bacteria found in the intestines; however, it is the few harmful strains that contaminate food and cause severe illness in humans. Current detection methods for E. coli are slow and costly, necessitating an improvement. One current method, the indole test, and a possible ammonia test using the colorimetric Berthelot reaction both rely on the reaction between E. coli and tryptophan to produce the respective products. This experiment will design a comparison between the two methods to determine if the ammonia test is a viable and/or more sensitive method for the detection of E. coli. It is predicted that the Berthelot reaction using salicylate will be the most sensitive method and the most applicable to rapid testing. This study also aims to develop a streamlined method for running this test using the method chosen in the first phase.

Effects of N-3 series fatty acids on the quantity and quality of pleopodal eggs and juveniles in freshwater crayfish

Anna Bricker

This project will study the effects of N-3 series fatty acids being added to the diet of freshwater crayfish on the number, size, cholesterol levels, and fat soluble vitamin numbers of their pleopodal eggs and juveniles. HPLC with UV detection will quantify the cholesterol levels and fat soluble vitamin numbers in the crayfish offspring . The objective of this study is to determine if N-3 series fatty acids affect the quantity and quality of the freshwater crayfish eggs and juveniles in order to connect N-3 series fatty acids with pregnancy health and fertility in human females.

No Change? Impact of FDA Warning on the Use of Opioids and Benzodiazepines and Their Effects in Older Allogeneic Hematopoietic Stem Cell Transplant Patients

Divya Bhargava

The purpose of the study was to determine the use and effects of benzodiazepines and/or opioids in older adults (65+) who received hematopoietic stem cell transplants (HCT) before and after the FDA's 2016 warning against co-prescription of opioids and benzodiazepines. The control group was the younger patients (40-64). Within the University of Minnesota Bone Marrow Transplant Database, patient and transplant demographics were collected, augmented with de-identified chart reviews to determine medication information. Analysis consisted of the general Wilcoxon, chi-squared, and logistic regression tests. The hypothesis was partially supported because after the FDA warning, the use of these specific medications decreased in the younger ($p<0.01$, 0.03) but not the older group. In older patients, only use of opioids was associated with significantly greater toxicities ($p<0.01$) and unfavorable discharge disposition ($p=0.05$). Although opioid and benzodiazepine use is common for controlling nausea and pain in older HCT patients, excess use of opioids compromises alertness and safety, contributing to toxicities and poor discharge disposition as well as the broader toxicities of polypharmacy and overall clinical risk. Continued attention to limiting their use may improve the safety and favorable outcome of HCT recipients; particularly the more vulnerable older patients.

The In Vitro Digestion of Animal-based Meat versus Plant-based Meat Alternatives

Maxanne Millerhaller

Given the environmental and animal-welfare benefits of plant-based alternatives to meat products, this experiment aimed to determine the digestibility of the protein in plant-based Beyond and Impossible burgers versus an animal-based beef burger using an in vitro model. Samples were homogenized and incubated with pepsin and trypsin to simulate protein digestion. A standard protein curve was created to determine the protein concentration of samples before and after digestion . Digestibility was calculated using the equation Digestibility(%)=(W0-W1)/W0x100, where W□ was protein concentration in the precipitate after digestion and W□ was protein concentration in the untreated product before digestion. The degree of digestibility using protein concentration was -23.02% for Beef, -42.92% for Beyond, and 4.25% for Impossible with a p-value of 0.000000003608717325. The degree of digestibility was also calculated using mass to obtain 69.12% for Beef, 59.60% for Beyond, and 57.32% for Impossible. However, the sample size for the determination using mass was only 1. Future studies should solely focus on the mass digestibility of animal meat versus plant-based meat alternatives.

Keywords: plant-based meat alternatives, Beyond Burger, Impossible Burger, protein digestibility

What Types of Masks Are The Safest to Wear

Ian Johnson

The purpose of my experiment is to find out what kind of masks are the safest to wear and how masks will help stop spreading sicknesses. The importance of my experiment is because I want to make sure that everyone stays safe and wears the right masks. I am doing this because I think people need to know that wearing mask is one of the most important things in the world right now. You should care because if you don’t wear a mask this virus is never going to end . I really hope you were able to learn something out of this.

Does Acetazolamide Reduce the Amount of Electrical Activity in the Brain, as Measured by Spike-Wave Index, During Sleep for Children with a Specific Type of Epilepsy Called LKS

Maggie Kane

The purpose of this experiment is to see if acetazolamide reduces electrical activity in the brains of children with LKS during their sleep. Abnormal electrical activity can affect learning, speech, and behavior in LKS patients, therefore it is important to know if there is a medication that is effective at treating this. This experiment was conducted by collecting the EEGs of five different children from both before and after they started taking acetazolamide. Spike-wave index percentage was read from the EEGs and compared from before and after starting acetazolamide to see if there was any difference. In 60% of the patients analyzed, the spike-wave index was reduced to 0% when they were treated with acetazolamide. This shows that acetazolamide can be an effective treatment for LKS. Further analysis of a larger number of patients may help support these results.

Drug Solubility of Acetaminophen

Grace Affeldt

The purpose of this project was to determine how soluble a certain type of pain relieving drug was in order to see how fast a person would feel relief. During the testing the main factor being tested was the total amount of time it took for the different types of Acetaminophen to dissolve. The experiment showed that when the acetaminophen of 500 mg was placed into 50 mL of white vinegar which was consistently moved at a speed of 100 bpm to simulate gastric motility and the pH of stomach acid. The Tylenol extra strength Gelcaps worked the fastest at dissolving completely into the white vinegar. Therefore the hypothesis "... if the pain relieving medicine is a Tylenol extra strength Gelcaps, then it will dissolve faster and become more effective" was supported by the experiment. The data was proven statistically significant on a significance of 0.05 and a critical value of 2.571. The experiment was conducted using four different types of acetaminophen which were tested six times each. Each pill of acetaminophen was 500mg of extra strength medication so the test stayed consistent. For each test a stopwatch was started when the acetaminophen was dropped into the white vinegar and stopped when the acetaminophen was fully dissolved.

Testing Hearing Frequency

Kaitlyn Groeneweg

In my project, I decided to test if different people could hear different frequencies. My hypothesis states: If I test out different people that range in age, gender, and if they have a medical condition, I can conclude which affect hearing most. I tested a group of individuals from my school for this experiment with their consent. I used the app called Hearing test from Audiogram. You can find the app on the app store and it is free. After each test, it provided me with a chart that showed someone's hearing compared to the average hearing that someone has. I put all of the data into a spreadsheet on Word Xcel. I started to compare the data and found that kids that range from 11-14 years old can hear better than kids who are 16-18 years old. I also found that females can hear higher frequencies since all of them were able to hear the higher tones at 30 and 40 decibels. The males however were more likely to hear the lower tones as they were able to hear the 5-10 decibels with ease. When looking at my data for medical conditions, none of them affected the hearing in a huge way. The only medical condition that affected the hearing drastically was a fractured hearing drum which makes sense. Overall, through my test, I can conclude that age and gender tend to have an effect on hearing but medical conditions don't make as much of a dent in hearing that gender and age do. I plan to keep this project going next year so that I can test more people and get a wider variety of results.

Extracting Iron from Breakfast Cereal

Liyu Tenkir

The purpose of this experiment was to determine the difference of iron in a healthy box of cereal compared to a sugary box of cereal. It is known that a cereal advertised as healthy might be more known to have more key nutrients like iron than cereals that consist of more sugar. The experiment consisted of a healthy advertised brand (Cheerios) and a sugary brand (Frosted Flakes). The data shows that more iron was extracted from the cheerios (1l.7mg) compared to frosted flakes (6.8mg). The experimenter had to extract iron from 10 serving sizes of each crushed cereal using a rare earth magnet which is a magnet with a strong magnetic force, and determine the amount of iron in each serving. The data was proven to be significant with a t-test score of 17.68 tested with 0.05 significance and a critical value of 2.262. The results shown supports the hypothesis. Which concludes that “healthy” cereal can have a rich source of iron.

Electrolyte Levels in Sports Drinks

Jack Machacek

The purpose of the experiment was to determine which sports drink had the most electrolytes out of Body Armour , Gatorade, and Powerade. The hypothesis was that Body Armour will have the most electrolytes , because it has coconut water, and also has the most carbohydrates out of the three drinks. An electrolyte is a substance that conducts electricity when it is dissolved in water, and they are needed for many things that the human body does. Electrolytes are lost in sweat or perspiration and need to be replenished. Body Armour, Gatorade, and Powerade are the three most popular drinks among athletes to get electrolytes. In order to find out how many electrolytes are in each drink the conductivity of each drink was tested. A multimeter was used to make a circuit containing wires that connected the multimeter to a 9v battery and a conductive sensor, which is two pieces of copper wire wrapped around a two inch piece cut from a plastic drinking straw. The entire process was repeated twelve times for the three sports drinks and eleven times for the Distilled water and Water . The data was analysed, averaged, and tee tables were made. Body Armour had the highest average milliamp conductance , which means electrolytes, at 69.6, Powerade was next at 56.8, after that was Gatorade at 41.9, then it was water at 20.4, and Distilled water had such a little conductance that the average was 0.1 milliamps. The significance of the data between Body Armour and Gatorade was 34.53, Gatorade and Powerade was 18.58, and Body Armour and Powerade was 14. Body Armour had the most electrolytes because it had coconut water and the most vitamins and minerals. The experiment was an overall success with many things that were learned and it will help athletes choose what to put into their bodies, and help them understand and know which sports drink has the most electrolytes.

CD8 T cell epitope generation toward the mutating SARS-CoV-2 spike protein in genetically diverse human population: Implications for disease control and prevention

Elisa Guo

Understanding anti-pandemic SARS-CoV-2 immune responses in the human population with different genetic backgrounds and tracking the viral evolution are crucial for successful vaccine design. The focus of this study is to investigate the generation of CD8 T cell epitopes by a total of 80 alleles of three major class I HLAs using the NetMHC 4.0 algorithm for the spike (S) protein that can be targeted by both B cells and T cells. Diverse capacities of S protein specific epitope presentation by different HLA alleles were observed with very limited number of predicted epitopes for HLA-B*2705, HLA-B*4402 and HLA-B*4403 and as high as 132 epitopes for HLA-A*6601, indicating individuals with certain HLA alleles, such as B*44 are more prone to SARS-CoV-2 infection. The analysis of 1000 S protein sequences from field isolates collected globally over the past few months revealed three recurrent point mutations including L5F, D614G and G 1124V. Differential effects of these mutations on CD8 T cell epitope generation by corresponding HLA alleles were noticed. Phylogenetic tree analysis and multiple alignment result indicated the absence of seasonal CoV induced cross-reactive CD8 T cells to drive these mutations. However, epitopes shared by SARS-CoV-2 and SARS-CoV that could be presented by multiple HLA alleles were identified. Studying anti-S protein specific CD8 T cell immunity in diverse genetic background is critical for better control and prevention of the SARS-CoV-2 pandemic.

The Affect Different Forms of Sugar Have on Glucose Levels During Metabolization

Evelynn Shero

The purpose of this experiment was to determine how different forms of sugar affect glucose levels during metabolization . Various orange-flavored products were used to represent sugar from natural/unprocessed foods, fruit/vegetable juice from concentrate, added/refined sugar, and alternative sweeteners. The enzyme invertase was used to demonstrate the body catalyzing the hydrolysis reaction of sucrose to its monomers, glucose and fructose. The hypothesis tested stated, if the invertase enzyme is added to the orange Sunkist soda, then it will have the greatest increase of glucose concentration after 25 minutes because it will break down sucrose into glucose the quickest due to its lack of fiber and nutritional value, causing a dramatic spike in glucose levels. The data was tested within a 0.05 significance and compared to a critical value was 2.262. The t-score was significant and the alternative hypothesis was accepted for all of the liquids, except the orange juice from concentrate vs. orange Sunkist soda. This particular set of drinks had a t-score of 0.875, which was less than the critical value of 2.262, so the null hypothesis was accepted. The results supported the hypothesis because Sunkist soda had the largest difference in glucose concentration after 25 minutes. Due to the refined and added sugars in Sunkist, glucose levels increased at a rapid rate. The orange fruit had the smallest difference and increased glucose concentrations at a steady rate because it includes nutrients such as vitamins and fiber, which helps slow down the conversion of sucrose to glucose.

The Effects of Fast Acting Sugars on Diabetics and Non-Diabetics

Lila Martin

My experiment was the effects of fast acting sugars on diabetics and non-diabetics. I did this experiment because I am a diabetic and I wanted to find a fast acting sugar that I and other diabetics would only have to take once. This is important to me because finding a type of food that stabilizes a diabetic's blood sugar is important to do. My project is important to me because I am a diabetic. In my experiment, I performed and set up the experiment through a series of steps. First, I put the continuous glucose monitors on. Then, I measured out all the different foods that I tested. Next, I tested all of the different fast acting sugars, specifically 15 grams of carbohydrates of each. After I performed my experiment, I collected all of my data and put the data in graphs. For my results, I found that 15 grams of carbohydrates in regular soda rose both the diabetic's and non-diabetic's blood sugar the most. I tested nine different kinds of fast acting sugars and the soda rose the diabetic's blood sugar by 18 mg/dL and the non-diabetic's blood sugar rose by 30 mg/dL. The soda actually did not raise the diabetic's blood sugar the most; rather the lemonade did. However, my experiment focused on which fast acting sugar rose both the diabetic's and the non-diabetic's the most. Overall, my results were, soda rose both the diabetic's and non-diabetic's the most.

Don't Fall Flat

Olivia Hamann

What is the best foot orthotic that has the least compression and will hold the proper shape recommend the longest between Dr. Scholl’s Orthotics For Arch Pain, Dr. Scholl’s Tri-Comfort, Airplus Plantar Fascia Orthotics, CVS Advanced Gel Orthotics, Superfeet, and custom 3d printed orthotics?
I think the 3D printed orthotics will have the least compression and will hold the proper shape recommend the longest because it is made out of hard plastic, and from previous prints I know that the 3d filament will not maneuver unless it has any small fine parts.
Step Four: Measured Creep and Recovery Behavior of 5 store purchased and one individually made orthotics
Step Five: Placed each orthotic on a level platform and provided consistent pressure using about 6 pound bricks
Provide data in a graphical format for easy reading of the compression trend.
My hypothesis studied for support compression of five different store purchased over the counter orthotics and one I designed and 3D printed to determine what orthotic provided the greatest support longevity with consistent weight applied over seven days. My analysis determined that my 3D printed orthotic was able provide consistent structural support with consistent measurements throughout the experiment. The CVS Advanced Gel Orthotics provided the least consistent support and would fully compress immediately when the consistent weight of the brick was applied. The Superfeet product was determined to provide the greatest consistent support and durability. Even though it was the most expensive store purchased orthotic, it provided the greatest value for the money.

Blood Sugar

Annika Engebretson

My brother has Type One Diabetes, so I pricked my finger, and he pricked his, because I wanted to know if your regular blood sugar changes if you have type one, and if you don't.

Examination of the direct effect of the Janus kinase inhibitor ruxolitinib on melanocytes

Lisa Wipf

Janus kinase (JAK) inhibitors have been tested as a potential treatment for the autoimmune disorder vitiligo by interfering with INF-y signaling to inhibit auto reactive CD8+ T cells which lead to depigmentation. Ruxolitinib inhibits JAK 1 and JAK 2 and has produced results of repigmentation for people with vitiligo. Most labs study the effect of JAK inhibitors such as ruxolitinib on the immune system but it has not been determined if there is a direct effect of JAK inhibition on melanocytes . Determining if ruxolitinib affects melanocytes or not could help lead to ruxolitinib becoming the first approved treatment for vitiligo. This experiment will grow melanocytes in the presence of JAK inhibitors to determine their effectiveness on melanocytes. After growing the cells for a period of time, they will be tested using RT-qPCR to observe the levels of IL-10. The levels of IL-10 will then be compared with the levels in a melanocyte culture grown without the presence of JAK inhibitors to determine whether or not there is a direct effect of JAK inhibitors of melanocytes.

A better approach to treating Alzheimer's? Multi-drug combination therapies in a C. elegans model

Ming Ying Yeoh

Alzheimer's disease (AD) affects millions of people worldwide. Despite the billions of dollars dedicated to researching the disease, no cure has been developed. Single-target therapies have been overwhelmingly unsuccessful due to the complex nature of the disease. Because AD is so multifaceted, treatments targeting multiple aspects of the disease have great potential. However, these have not yet been widely tested. Therefore, this study intends to determine the efficacy of single and combination therapy using drugs that target different aspects of AD: Sulforaphane (is anti-inflammatory and anti–oxidative stress), spermidine (promotes autophagy of harmful proteins), and Methylene Blue (inhibits toxic protein aggregation), on a transgenic C. elegans model of AD. Using a relatively cheap and simple C. elegans model and drugs that are naturally-occurring (sulforaphane and spermicide) or FDA-approved (Methylene Blue) also allows for more rapid screening of treatments, accelerating the pace of drug development for this still incurable disease.

The Effect of Frequencies on Healing in Crayfish

Grace Liu

The effect of frequency on both emotional and physical healing has not been widely studied . Although some studies have demonstrated that certain frequencies and music, there has not been much research into if it is truly valid. If certain frequencies can in fact speed up or improve healing, there would be many more treatment options available to all as one could play certain frequencies from their own devices. This study will be using crayfish(Cambarus bartonii) to test the effect of different frequencies on wound healing . A small hole will be made by carefully drilling into the carapace of the crayfish . Measurements will be made periodically measuring the rate of healing and data will be recorded on the frequency that crayfish has undergone. Final conclusions will analyze if there is any evidence of frequencies increasing the speed of healing.

Impact of Nutritional and Human Factors on Blood Glucose in Diabetic and non-Diabetic Subjects

Rushil Khadilkar

Diabetes has been labeled the silent killer of the developed world due its asymptomatic onset with devastating long-term impact on the entire human body. The causes of this disease are complex [10], further confounded by the challenges of managing it in the modern world dominated by sedentary lifestyles, processed foods, and stressful professions. Managing the disease through understanding and controlling of diet and lifestyle is the best current approach for most people to avoid long term damage. This study focuses on human (age & diabetic status) and nutritional factors (Glycemic index (GI), weight and type of food) to experimentally demonstrate their impact on blood glucose levels. Multiple regression analysis of the experimental data is conducted to identify statistically significant factors and interactions. Diabetic status, Glycemic Index and weight of food and their interactions are shown to be significant factors in the study. The regression models based on this analysis provide a powerful tool to manage this deadly disease, daily, on a personal level. A Smartphone App developed for this purpose uses the regression modeled factors to display glucose levels of the food choices and suggests alternatives to mitigate long term complications and adverse outcomes of this disease.

Platelet rich plasma and its effectiveness in regenerative medicine

Brynn DuLac

Successful Cessation: Thwarting Tobacco Addiction Using Very Low Nicotine Content Cigarettes without Exacerbating Depression Symptoms

Sarayu Goduguchinta

Tobacco cessation is the process of discontinuing the use of tobacco products . Many studies have been conducted to analyze the effects and effectiveness of various cessation methods , specifically regarding very low nicotine content cigarettes. However, not many studies have been done on the effects of tobacco cessation on populations with psychiatric comorbidities. The purpose of this study is to characterize and quantify how different tobacco cessation methods affect the prevalence of depression symptoms in smokers with major depressive disorder.

The effects of gradual and abrupt tobacco cessation using very low nicotine content cigarettes in smokers with major depressive disorder has been examined in a previous study. In order to examine how symptoms of depression may persist or be aggravated, data from this study and previous relevant studies will be compiled. That data will then be analyzed for trends regarding depression in the context of tobacco cessation

This work can help smokers with psychiatric conditions attempt to quit tobacco while being aware of what may happen to their already present symptoms. Because of this, adjustments can be made to help cessation attempts to be more successful in this population.

Analysis of Gene Expression Changes Influenced by Various Severe COVID-19-associated Single Nucleotide Polymorphisms

Hubert He

The purpose of this project is to research a less commonly investigated potential cause of COVID-19 severe symptoms (respiratory failure), that being the identification of how certain high COVID-19 respiratory failure-associated Single Nucleotide Polymorphisms (SNPs) affect gene function and expression, and how these altered genes and the pathways they belong to suggest an increased risk of severe COVID-19-related illness. The two SNPs that were chosen for further analysis were rs143334143 and rs11385942, which were recently reported in human genomics studies of severe COVID-19 respiratory failure.

The public database GTEx was used to identify and compile genes whose expression levels are highly associated with these SNPs. The bioinformatics tool QIAGEN IPA was used to perform a pathway analysis on these genes, identifying the biological pathways they belong to. Results show that some associated genes are crucial to the pathways that mediate immune response, and some associated genes may be indicators for other abnormalities in these pathways.

This project contributes to our understanding of COVID-19 from a novel angle: that of genetic polymorphisms and how they affect gene expressions and biological pathways. The observations made from this research provide insight into the pathways involved in controlling viral infection and immune function, which are relevant to COVID-19 severe symptoms.

An Active Role for Machine Learning in the Diagnosis of Cardiac Arrhythmias, Year 2

Quentin Hughes

Atrial Fibrillation (AF) is a cardiac disease affecting over three million Americans, with a prevalence of 1% (above 6% in the elderly).2 AF is an irregular heartbeat that can lead to blood clots, stroke, heart failure and death. Annually, AF is responsible for over 750,000 hospitalizations and 130,000 deaths in the U.S.3 Accurate and early diagnosis is key, however, the disease is significantly under-diagnosed. Monitoring devices can acquire large amounts of real-time ECG images but evaluating this big data remains a challenge. Diagnostic accuracy with current technologies is high but false positive rates are between 27-90%. There is a growing need for automated image analysis. This study aims to create a supervised machine learning algorithm that will reliably identify AF and reduce the false positive rate. 5,761 pre-classified ECG images were collected, augmented and classified as either AF or NOT for binary analysis. It was hypothesized that a machine learning algorithm could be built to diagnose AF that maintains sensitivity while significantly reducing the false positive rate. The optimal model included seven convolution neural networks, four dense layers and nine epochs. Testing the final model on the validation images resulted in sensitivity of 94.7%, specificity of 95.1% and a false positive rate of 4.9%. With a consecutive-image trigger, the false positive rates are dramatically reduced (< one per 10 years). Using this algorithm to diagnose AF can potentially achieve similar accuracy and a significantly lower false positive rate than the reported algorithms used today.

Using Artificial Intelligence and Electronic Health Records to Build a COVID-19 Testing Model

Vaughn Hughes

Atrial Fibrillation (AF) is a cardiac disease affecting over three million Americans, with a prevalence of 1% (above 6% in the elderly).2 AF is an irregular heartbeat that can lead to blood clots, stroke, heart failure and death. Annually, AF is responsible for over 750,000 hospitalizations and 130,000 deaths in the U.S.3 Accurate and early diagnosis is key, however, the disease is significantly under-diagnosed. Monitoring devices can acquire large amounts of real-time ECG images but evaluating this big data remains a challenge. Diagnostic accuracy with current technologies is high but false positive rates are between 27-90%. There is a growing need for automated image analysis. This study aims to create a supervised machine learning algorithm that will reliably identify AF and reduce the false positive rate. 5,761 pre-classified ECG images were collected, augmented and classified as either AF or NOT for binary analysis. It was hypothesized that a machine learning algorithm could be built to diagnose AF that maintains sensitivity while significantly reducing the false positive rate. The optimal model included seven convolution neural networks, four dense layers and nine epochs. Testing the final model on the validation images resulted in sensitivity of 94.7%, specificity of 95.1% and a false positive rate of 4.9%. With a consecutive-image trigger, the false positive rates are dramatically reduced (< one per 10 years). Using this algorithm to diagnose AF can potentially achieve similar accuracy and a significantly lower false positive rate than the reported algorithms used today.

Testing, Testing: Developing an All-Strain-Inclusive Test for SARS-CoV2

Elizabeth Levinshteyn

First detected in China in 2019, COVID-19 became a global pandemic with 95.4 million cases of COVID-19 and 2.03 million deaths reported as of January 18, 2021. COVID-19 is a respiratory disease caused by an RNA virus SARS-CoV2. The test for COVID-19 developed by the CDC uses RT-qPCR (reverse transcription quantitative polymerase chain reaction), in which the portion of SARS-CoV2 genetic sequence is amplified and quantified. This test has a relatively high false-negative rate due to its inability to detect new variants of SARS-CoV2. I was interested in developing a new test for COVID-19 that would detect all variants of the SARS-CoV2 virus. I analyzed different regions of the SARS-CoV2 genome for their similarity to other fully sequenced betacoronaviruses and their mutation rate. I used publicly available databases and bioinformatics software tools to determine the regions of these proteins that would yield the most accurate results when used as the basis for the test. Based on my analysis, the nsp3, nsp4, and S proteins were the most viable contenders based on these two criteria. Two regions I selected were located in the S gene and nsp4 gene. Notably, the N protein, currently used in the CDC test, had the highest mutation rate out of all other regions. In conclusion, I designed a new test for COVID-19 that will likely yield fewer false-negative results due to its tolerance for new SARS-CoV2 variants.

Stop the Clot: The Effect of Anticoagulants on Thrombosis

Evelyn Danz

Stop the Clot: The Effect of Anticoagulants on Thrombosis
Evelyn Danz, 6830 Canterbury Lane, Eden Prairie, MN 55346
Avail Academy, Edina, MN 55416
Teacher: Susan Koppendrayer

This experiment is important because over 60,000 Americans die of thrombosis, or unexpected blood clotting, every year. Anticoagulants work with chemicals in the body to reduce unexpected blood clots. The purpose of this experiment was to see what dosage of sodium citrate (an anticoagulant), reduces blood clots the best. This project is important right now because Covid-19 can trigger the blood clotting reaction in Covid patients and can be life threatening. The independent variable is the amount of sodium citrate in each container. The dependent variable is how thin sodium alginate (a substitute for blood in the experiment) becomes after it goes into the sodium citrate solution. The first hypothesis was 1.5% sodium citrate will thin the best because the more sodium citrate used, the thinner the blood gets. The second hypothesis was 2% sodium citrate is too much and if someone took that much it could cause too much bleeding. The procedures included dropping five balls of sodium alginate solution into four solutions each containing the same amount of calcium chloride and different amounts of sodium citrate. After one minute in the solution, the sodium alginate was taken out and measured in millimeters. The results of this experiment were that 1.5% of sodium citrate is the best dosage because it makes blood thin enough to prevent thrombosis while the blood keeps a healthy level of clotting.

Kids vs. Screens

Iona Heddle

Kids vs. Screens: How do screens affect a child’s focus?
Iona Heddle 4255 Jefferson street cottagewood
Avail Academy, Edina, MN 55426
Mrs. Susan Koppendrayer

This science fair project is about how screens affect a child's brain. It is a project that will determine whether or not screens are good for a child's focus. The experiment that took place was where a group of first grade students took a quiz having watched no screens at all and then on the same day of the week they took the same quiz but this time they watched a screen before they took the quiz. Then the results were compared and the comparison was really quite surprising.

Do masks affect your oxygen levels and heart rate?

Carter Miedema

Do masks affect your oxygen levels and heart rate?
Carter Miedema, 6232 Coteau Trail, Eden Prairie, MN 55344
Avail Academy, Edina, MN
Teacher: Mrs. Susan Koppendrayer

During the Covid-19 pandemic, many people have been asked to wear a mask in order to protect people from the virus and decrease the spread. Some people have raised concern that masks limit their ability to breathe. This poses a question: Do masks affect your oxygen levels and heart rate? The purpose of this experiment was to see if wearing a mask affects oxygen levels and heart rate. The independent variables were middle school students. The dependent variables were the oxygen levels and heart rate. The controlled variable was wearing surgical masks. The hypothesis was that wearing a mask would not affect heart rate or oxygen levels. Thirty-six middle school students at Avail Academy were tested with and without masks. Methodology for this experiment: 1st obtain O2 sat monitor, a spreadsheet, and some Chlorine wipes. Five subjects were tested twice each day, once at the end of the first period while wearing a mask and again after lunch without a mask. This was repeated daily till all middle schoolers were tested. The results were that oxygen levels stayed exactly the same with and without masks. When comparing heart rate, there was a slight increase in heart rate when not wearing a mask. Results were similar between boys and girls. This project shows that it is safe to wear masks in school. In conclusion, wearing a mask does not affect heart rate or oxygen levels.

Evaluating the effectiveness of Cellulose Acetate membranes as a replacement for mouse skin in permeability studies

Cole Rabe

Prosthetic Index Finger Operated by Surface Electromyography

Kareem Eldahshoury

The impact of green tea on bacterial nanocellulose’s biomedical properties

Lauren Benoit

The purpose of this research is to discover if green tea can be used to create Bacterial Nanocellulose compared to the black tea used in the Sharma and Bhardwaj study. BNC can be used in the medical field for many applications, specifically for improved healing for burn and wound victims. By itself BNC does not have enough antibacterial properties therefore it must be combined with multiple other substances to meet the antibacterial requirements needed for medical applications. The BNC will be grown using green tea and herbal extracts in an attempt to increase the antibacterial properties. This study will use E. Coli and A. Varidians to determine if the modified BNC will be able to destroy bacteria. The impacts of the E. Coli and A. Varidians on the BNC films will be observed using multiple techniques including analyzing the film 's morphology, porosity, thickness, and an agar well diffusion assay.

Examination of serotonin levels in crayfish exposed to high ambient temperatures

Adelyn Diaz

As the global climate becomes warmer, heat waves are becoming increasingly common. Extreme heat has negative impacts on mental health, and an Australian study showed a 7.3% increase in hospital admissions for all mental-behavioral disorders during periods of extreme heat (Hansen et al. 2005). The largest proportion of this increase in hospital admissions (mood affective disorders) is also the group that is at a higher risk of suicide due to their illnesses. A previous study by Kim et al. (2019) identified a positive correlation between ambient temperature and suicide occurances, and a study by Maes et al. (1995) identified a negative correlation between 5-HT biomarkers and violent suicide rates. The aim of this research is to detect alterations in the serotonin (5-HT) levels of crayfish when exposed to high ambient temperatures in a controlled environment. Serotonin levels will be tested for and analyzed for correlations to temperature.

Investigating the effect of Lactobacillus plantarum, Lactobacillus reuteri and Lactobacillus gasseri on the gut microbiome of the model organism C. elegans using a lifespan assay

Shreya Kumar

In the nick of time: Determining the positive and negative regulators of nickase Cas9

Arnav Gupta

Genetic editing is a powerful tool, yielding profound knowledge about the human genome and holding the potential as a life-changing tool for people afflicted by disease. Using nickase Cas9 is very expensive and lacking efficiency; with less than 1% efficiency it's no wonder genetic engineering is so difficult. The purpose of this study is to find positive and negative regulators of nickase Cas9, to help increase editing efficiency for future uses. Analyzing the proteins and gene sequences to identify changes in the Next-seq readings will be indicative of a regulator at work, which will then shift the focus to isolating them.

By mutagenizing cells with Blasticidin and IMPDH and selecting for those with the mutation I can analyze which cells were cut and edited by Cas9, relying on a comprehensive list of every protein and gene created by the University of Minnesota Genomic Center. This process is allowing me to find if there were any activity in excess of normal levels of editing, meaning there was something accelerating the work of Cas9.

Next steps of this project include continuing to analyze additional samples so that the findings are robust and conclusive. Using known positive regulators for Cas9 can help science and research utilize the tool effectively. Future disease treatment approaches aspire to effective application of genetic engineering. Steps, such as the one detailed in this study, are critical for advancing our understanding of the technology and developing ways to improve its efficiency.

Mitigating Metastasis: Utilizing cancer-associated fibroblasts to stop the spread of cancer

Fazila Mohamed Prem Navaz

When cancer spreads from one organ to another, it becomes significantly harder to treat, and health outcomes for patients decrease. This process, known as metastasis, is involved in 90% of cancer deaths. Because metastasis presents a serious barrier to effective treatment and recovery, it is crucial to understand what role cancer-associated fibroblasts (CAFs) play in breast cancer metastasis and progression. This study is aimed to understand how CAFs, which account for 80% of the fibroblasts population in a tumor, influence metastasis.

The role of non-cancerous cells in the tumor microenvironment are important to cancer metastasis and have been studied through in vitro and in vivo models. It was learned that CAFs are directly correlated to the metastatic potential of cancer. It increases circulating tumor cells (CTCs) ability to migrate through the basement membrane into the blood or lymphatic vessels and invade other organs. The experiments show that HAase treatment of cancer cells significantly decreases CTC co-clustering with CAFs. In this study, we show that depleting Hyaluronic (HA) partially inhibits the CAFs binding to endothelial cells. This evidence suggests that HA expressed on CAFs plays a role in facilitating CAF/CTC extravasation from the circulatory system into secondary sites and thereby increases metastasis.

Understanding these mechanisms will define new therapeutic targets aimed at disrupting cCAF/cCSC (Cancer Stem Cells) clusters to prevent metastasis and signaling crosstalk to eliminate metastasize and ultimately lead to more effective treatment plans and better patient outcomes.

Mighty Muscles: Examining Teratoma-derived Muscle Stem Cells and the Behavioral Tendencies of These Powerful Cells

Julia Karls

Through stem cell therapy, skeletal muscles damaged by muscular dystrophy can reproduce to form fresh muscle fibers, but regeneration is most reliant on satellite cells that lie adjacent to the muscle. These cells have been proven adept at differentiating into myotubes when cultured in vitro, but lack the ability to reproduce efficiently when transferred into fresh growth mediums, a process termed passaging, that allows for the growth of additional cells from a specific cell line. Experiments undertaken in mice have proven the regenerative capabilities of teratoma-derived muscle stem cells by demonstrating their ability to regenerate after injury. My research focuses on how expanding these cells will affect their health and multiplication, and investigates the similarity of their behavior to muscle satellite cells.
To study the effects of passaging on teratoma-derived muscle stem cell regeneration, images were taken before expansion and after 8 and 18 passages. This data was analyzed using Image J, revealing teratoma-derived muscle stem cells to be capable of forming myotubes when expanded; however, the extent of their efficiency is questionable. The data proved unpassaged cells to contain the most myogenic potential, with expansion decreasing myotube formation and the number of nuclei enclosed. Although no statistically significant differences have been shown yet among the datasets of fresh to passaged cells, a downward trend resulting from expansion was evident, illustrating teratoma-derived muscle stem cells similarities to behavioral tendencies in muscle satellite cells in vitro. Next steps will include investigating the myogenic potential of these cells after transplantation in vivo.

T-HS-CHEM-0124

How different types of liquids are affected by different types of heat transfer

Camden Route

How do different pH levels and different nail coating affect the formation of rust on nails?

Maisy Scheuneman

The purpose of the experiment was to determine how different pH levels and different protective coatings affect rust on nails . The hypothesis was, if a hot-dipped galvanized nail was in a pH level of about nine for three weeks, rust formation will decrease because hot-dipped galvanized nails have the most even and thickest amount of coating and rust decreases in pH levels greater than eight. To conduct this experiment the experimenter had to split forty electro-galvanized nails, forty hot-dipped galvanized nails, forty bright nails, and forty zinc-plated nails into thirty-two plastic cups with plastic lids with five nails per cup. After letting the nails sit for three weeks, the experimenter found that their hypothesis could not be supported. The hot-dipped galvanized nails did not rust in any of the four pH levels because of the thick and even amount of coating on each nail. The data was then tested using a 0.05 level of significance and a 2.262 critical value. The mass did not make a significant change to say the hypothesis was correct. Therefore, the null hypothesis should be accepted.

Slime: A Scientifically Tangled Mess

Summer Nelson

TITLE PAGE: Slime, A Scientifically Tangled Mess

ABSTRACT:
This paper explores the effects of various "activators" on the outcome of homemade slime. Slime is the well-known name for the popular squishy, stretchy substance available in many colors and varieties.
Slime is neither liquid or solid, it is a Non-Newtonian fluid, meaning it acts like a liquid when you pour it or ooze it through your fingers and as a solid when you put it under pressure like pounding it. Those are the qualities that make it fun. Mattel Toys created what's known as slime, in 1976. It was marketed as gross and was a green goo offered in a plastic trash-can. With COVID 19 and local stay-at-home precautions, today's fascination is in making homemade varieties of every color with everyday household ingredients.
The making of slime involves chemistry. It's all about how different materials are put together to cause the desired chemical reaction.
The internet offers lots of slime recipes. Some with glitter, some glow-in-dark, some are fluffy, some slippery, and all are rubbery. This paper examines slime, created with a base of glue and shaving cream, to which various common household activators were added. Borax, contact lens solution and liquid laundry detergent were the activators used in these experiments. Shaving cream is used to make the slime fluffier. Without shaving cream, slime can still be created.
Tests were designed and conducted with each activator to measure the thickness of the slime, the stickiness of the slime, and the slime's stretchiness. Not all recipes found on the internet use Elmer's glue, and so the first set of experiments were conducted with generic glue. Those tests failed to produce usable slime. The experiments were repeated with brand-name glue, and slime was created, though each activator gave a different outcome or a different chemical reaction.
What activators made the most durable, stretchable, and smooth-to-the-touch slime?
The results from these experiments show, with Elmer's glue and a shaving cream base, the laundry detergent gave the best results.

Does Temperature Affect a Volcano's Eruption?

Giselle Guasco Paucar

The Question I tried to answer was " Does Temperature affect a Volcanoes reaction" because what I wanted to figure out was 2 thing one does temperature affect a volcanoes reaction two kind of goes with number one but I want to know how long each eruption for each volcanoes took. For my procedures I followed. I first had all my measurements ready and my liquid temperature which was my vinegar that was Hot , cold or room temp. For the next three trails I used all temperatures in different trials and added vinegar to each temp liquid. Before starting each trail I setted a stopwatch and started it. I saw a reaction between vinegar and baking soda (until I saw the fizzing foam come out of the volcano). Finally I just had to wait until the fizzing foam stopped to stop the stop watch and gather my data together. What I got was for the hot temp that was 120 degrees and lasted 10 seconds of reaction between the vinegar and the baking soda. For the room temp I had 50 degrees and had a lasting of reaction time of 22 seconds and my last temperature was cold temp. I had 40 degrees from that temp. The lasting reaction time for cold was 10 seconds. Incunclution temperature did affect the volcano's reaction and timing as we see what I got for my result. We get that Hot temperature takes the shortest time and cold takes the longest time and room took not the longest not the shorted but stayed in the middle range.

Dissolving Sugar Cubes

Isaac Wening

I performed an experiment to test what liquid would dissolve a sugar cube the fastest. I measured the liquid and sugar cubes to ensure they were the same, then began the dissolving process. While they were dissolving I stirred the cups in a consistent way every minute until the sugar cubes dissolved and tracked the time. The results of the experiment showed that liquids with carbonation dissolved the sugar the fastest.

Sunscreen Panic

Alex Sum

I'm testing four different type of sunscreen brands to see which one will work better in the sun and protect you from Sunburn

Baby Ganics Copper Stone
Banna Boat CeraVe

De-Enhancing the Permeability and Retention Effect

Nathan Sun

Nanoparticles are being tested to increase the effectiveness of chemotherapy. There is promising potential with nanoparticles because of the Enhanced Permeability and Retention Effect - one such effect is the prolonged retention at a desired site. Although it might be beneficial for the first batch, it reduces the retention of the following batches. This proposal hopes to synthesize a Dysprosium Complex that would reduce the retention time of the first batch, allowing following batches to deliver drugs consistently.

Mighty MOFs: Investigating 1-butene dimerization on UiO-66 variants to improve alpha-olefin production

Benjamin Kroul

Dominic Greco

The dimerization of 1-butene is a mechanism that is vital to the production of alpha-olefins, which have applications in the production of recyclable plastics, synthetic lubricants, and detergents. Current industrial methods of producing alpha-olefins involve homogeneous and zeolite transition metal catalysts, which are inefficient because they require additional processes to separate catalysts from solution and facilitate unwanted side reactions. This study investigates the effectiveness of the metal-organic framework UiO-66 in the dimerization. UiO-66 is composed of inorganic zirconium nodes each surrounded by 12 organic linkers, forming a stable and highly tunable framework. Deposition of transition metals (M+) into the nodes creates active sites where catalysis occurs. A Cossee-Arlman reaction mechanism describes the dimerization of 1-butene on M+/UiO-66 in the production of linear octenes and ethyl-hexene. To determine the catalytic activity and product selectivity of UiO-66 variants in the dimerization, we modeled reaction cycles using nickel and chromium as transition metals and benzoate, fluorobenzoate, and aminobenzoate as linkers. Calculations were performed using density functional theory in the Gaussian 16 program to get optimized structures and free energies for each intermediate in the dimerization process. Our data suggest that a nickel catalyst with benzoate linkers is the most efficient. One reason for this could be the ability for nickel-based catalysts to have high selectivity towards linear products, a pattern called the nickel effect. Our research can be applied to the production of alpha-olefins as industry will begin to shift from the current inefficient catalysts to MOFs.

On your mark, get set, bake

Lily Stel

Abstract
Have you ever baked a loaf of sourdough bread and it just flopped? Was it as flat as a pancake? If your bread was like this, you must have been using the wrong type of flour. In my science fair project, I tested three different types of flour to see which one helped my bread rise the greatest. My hypothesis is that when I bake bread from three different sourdough starters, whole wheat flour will rise the greatest amount.
The experiment that I performed included making three different sourdough starters . I tested which starter rose the most in sourdough bread. I used all purpose flour, whole wheat flour, and bread flour. One problem I ran into was that my white flour starters did not grow very much during the experiment. It ended up being OK, and I still got good results from my experiments.
When I made my bread, the average height of the loaves of bread for each section was 6.4 centimeters for all purpose flour, 5 centimeters for Bread flour (which was also my control), and 7.4 centimeters for whole wheat flour. For each loaf of bread, I measured how much it rose. Then I took the average of each of these measurements and found the average. My conclusion is that whole wheat flour rose the greatest amount of the flours that I tested.

Cookie Flour Power

Avery Cantwell

Have you ever wondered what flour to use when baking chocolate chip cookies? You want a small and delicate cookie, but you don't know where to start? In my science fair project I tested different types of flour to see which would give baked chocolate chip cookies the largest diameter. My hypothesis was that when I bake chocolate chip cookies using six different types of flour, the cookies made with almond flour will have the largest diameter.

The experiment I performed was baking cookies with 6 different types of flour and then measuring the cookie with the largest diameter. There were no problems with my experiment. The most difficult part of my experiment was making sure the size of the cookie scoop was the same, mixing the ingredients for the same time, and baking at the same temperature for the same time.

The data I recorded was that the cookies with whole wheat flour measured 6 cm, the cookie with unbleached all-purpose flour was 6.2 cm, the cookies with cake flour measured 6.9 cm. The cookies with bleached all-purpose flour were 6.3 cm, the cookies with almond flour had a diameter of 11 cm, and the cookies with gluten free flour measured 9.1 cm. I recorded the largest cookie diameter of each of the 6 types of flour in the cookies I baked. My conclusion is that the cookies with almond flour had the largest diameter of the 6 flours I tested.

Coin Cleaning

Matthew Craig

The purpose of my experiment was to find out what mixture or substance best cleaned copper oxide off of coins . My hypothesis was that 30ml of baking soda and 15ml of water would be the best cleaner because there are elements in baking soda that would take the copper oxide off. 30ml of water and 15ml of salt will be the least effective in cleaning coins, because water doesn't have elements in it that are very well suited for the job. Copper has more protons than electrons making it positively charged. Oxygen has more electrons than protons making it negatively charged. Like a magnet they attract each other and after a while the oxygen merges with the copper forming copper oxide. Copper oxide will dissolve in a weak acid like vinegar. Putting it in a substance or mixture that is negatively charged will draw off the copper oxide too, but it will also take off the very outer layer of copper on the coin. That information was researched and found in more than one place. I took front and back pictures of five pennies. Then I made my mixtures: vinegar and salt, baking soda and water, tabasco sauce, coca cola, and water and salt. I put the pennies in those mixtures and let them sit there for five minutes. Afterwards I took them out, washed them off, and dried them. Then I took front and back pictures of the coins again. I did this twice with pennies. Then with the two cleaners with the best results, I did it again with two dimes and two quarters. I took pictures of the coins so that the difference between before and after cleaning could be seen . I described the difference I saw in the coins. My conclusion is that my hypothesis was wrong. The best coin cleaner was vinegar and salt. Tabasco sauce was the only other thing that did anything to the coins. Everything else did nothing very noticeable.

Exploding Experiments

Lauren Craig

The purpose of this experiment was to find the best combination of materials to make the best toy volcano-like eruption. I had five combinations, vinegar and baking soda, ketchup and baking soda, lemon juice and baking soda, hydrogen peroxide and yeast, and Mentos candies and diet coke. I researched all five combinations and my hypothesis was that the Mentos candies and diet coke eruption would be the highest. For my experiment I made the volcanoes erupt one at a time by putting the materials in bottles that acted as the volcanoes and than added the reaction ingredients. I had the bottle that was erupting next to a yardstick to see how high the eruptions were, and I videotaped the eruptions to see how long they were. I then put this data into a table. In conclusion I found that the lemon juice and baking soda and the hydrogen peroxide and yeast eruptions were the highest and were about 1.3cm high according to the yardstick, but the ketchup and baking soda eruption was the longest at 2.5 minutes.

Betting on Bioinformatics:
A fight to the death for SARS-CoV-2!
Decoding the effectiveness of the SARS-CoV-2 vaccines against its many variants

Rahul Balaji

In the span of 12 months, COVID-19, also called SARS-CoV-2, has spread like a wildfire starting from a small Wuhan village in China to the rest of the world. Due to the virus's highly mutagenic nature, and its zoonotic transmission, many mutations have developed. Our government has been able to manufacture vaccines that will help stop the spread of the virus and help stabilize the economy. But, with the rapid spread of COVID-19, many different variants and strains have been identified, seriously affecting treatment approaches. It is critical to understand whether the SARS-CoV-2 vaccines developed will be effective against these newly identified variants.

Using Virus Pathogen Database software, it is possible to analyze data and characteristics of the many strains and variants that have been identified. In this research, a total of 25 different strains were collected and utilizing a feature called BLAST, comparisons were made among the different variants to assess if the genetic differences between strains would impact the effectiveness of the vaccine. This analysis shows that many of the different variants have major differences in genetic make-up that could potentially adversely impact the effectiveness of the SARS-CoV-2 vaccine.

This foundational study is critical for assessing vaccine effectiveness and for directing priority next steps. Indications are that alternative vaccine options will be needed to counteract the effects of these variants on human hosts to stop the spread regardless of genetic differences. With these tools, we will be successful in counteracting the spread of SARS-CoV-2 and saving lives.

Upsurge of the Glycolytic Pathway in Cancer: A Dynamic Network Analysis of Oncogenic Mutations in Phosphofructokinase-1

Johnny Yue

Sydney Peng

Phosphofructokinase-1 (PFK-1) is an allosteric enzyme in glycolysis that regulates the ATP-dependent phosphorylation of fructose 6-phosphate (F6P) into fructose 1,6-bisphosphate. In different forms of cancer, PFK-1 has been shown to be upregulated in an uncontrolled glycolytic pathway to fuel nutrient metabolism for different tumors. To investigate how cancer can lead to unregulated glycolysis, we used molecular dynamics simulations and computational models to create a network analysis based on the atomic motion correlation between the regulatory and catalytic sites on wild-type and oncogenic R210H-mutated PFK-1. It has been believed that oncogenic PFK-1 will have a complete breakdown of connections between receptor sites for regulatory ligands and the catalytic site. However, our research shows that its molecular dynamic network is rather enhanced to ensure efficient communication between ADP-bound regulatory domains and F6P catalytic domains. The number of atomic nodes present on the F6P domain of the mutated enzyme is significantly greater than that of a wild-type enzyme, potentially showing a higher ability for R210H PFK-1 to convert fructose 6-phosphate. In addition, the average shortest distance between the 2 domains of the mutant PFK-1 is significantly smaller than that of the wild-type enzyme, suggesting that communication may be more efficient between different parts of the enzyme rather than completely disconnected. The number of paths between the F6P-catalytic and ADP-regulatory domains are also significantly larger for oncogenic PFK-1, providing evidence that the number of possibilities for the catalytic and regulatory domains to establish connections is actually increased in cancer.

Genes and Data Science... where do they cross paths?

Corrina Benson

Examining the Relationship Between Socioeconomic Status and Soil Macronutrient Levels

Gavin Kimmel

Community green spaces have recently gained popularity due to their extensive physiological, social, and environmental benefits. However, it must be understood if socioeconomic status impacts the soil quality in the surrounding neighborhood so as to allow communities with fewer resources to create equally sustainable and bountiful green spaces. In this study, soil quality was defined by the three macronutrients required for plant growth: nitrate-nitrogen, phosphorus, and potash, referred to as N-P-K. Soil samples were collected from public parks within four neighborhoods throughout the Twin Cities , all with varying socioeconomic statuses, as reflected by their median household incomes. After the samples were tested for their N-P-K concentrations, a relationship between median household income and each macronutrient was analyzed. Nitrate-nitrogen exhibited a positive correlation ($r = 0.473$) and phosphorus and potash exhibited negative correlations ($r = -0.263$ and $r = -0.444$, respectively). However, all three relationships provided insignificant p-values ($p \leq 0.05$). Although no significant relationship between median household income and soil N-P-K levels was found on a passive, chemical level, plants should be grown in the neighborhood’s soil to explore how sustainable it is in an active sense .

The Impact of Elapsed Burn Time on Restored Prairie Plant Biodiversity and Soil Nutrient Content

Isabel Medrano

Prescribed burning is a common method of prairie restoration, which is increasingly important because of the scarcity of natural prairie remaining in North America. This study aims to examine the relationship between the time elapsed since a prairie was last burned, and both the plant biodiversity as well as soil nutrient content. Three sections of restored prairie were studied at the Cowling Arboretum of Carleton College in Northfield, MN. Each of the three sections of prairie (B2, D2, and D3) were burned at different times, with elapsed burn times of 0.5 years, 2.5 years, and 6.5 years respectively. Plant biodiversity within each plot of prairie was measured using a quadrat sampling method and Simpson's diversity index. Soil samples were collected from within each quadrat for soil nutrient analysis of nitrogen/nitrate and phosphorus concentrations. Data analysis showed that more recently burned plots of prairie (B2 and D2) had significantly greater plant biodiversity in comparison with plot D3, indicating that longer elapsed burn time negatively affects biodiversity. Elapsed burn time also negatively affected phosphorus concentration, however, the opposite was true for nitrogen/nitrate concentration.
Key words: restored prairie, biodiversity, prescribed burning, soil macronutrients

The Effect of Rising Temperature on the Polystyrene Degradation Rate of the Superworm, Zophobas atratus

Pilar Saavedra-Weis

The purpose of the experiment was to determine whether rising temperature affected the polystyrene (PS) degradation rate of the superworm, Zophobas atratus. Four different groups were maintained at different temperatures in incubators : a control group maintaining a temperature of 25°C, two experimental groups that maintained temperatures of 27°C and 29°C respectively, and one experimental group that changed temperature over time (25°C → 27°C → 29°C). The PS degradation rate over time (mg/hr) and the survival rate of Zophobas atratus over time (%) were collected every three to four days for a total of 21 days. There was no significant difference in PS degradation rates between the groups at different temperatures . There appeared to be a decrease in the survival rate of the experimental group that increased in temperature over time compared to the other groups. The hypothesis was not supported because it was predicted that the groups at higher temperatures would have higher degradation rates, but this was not the case. It is likely that this occurred due to the superworms adjusting to the temperature changes, or the lack of replicates in the experiment which led to inconsistent results.

Identifying the Growth Window for Didymosphenia geminata: A Method for In-lab Growth

Will Sedo

Diatom algae Didymosphenia geminata, found in fast-flowing, cool, oligotrophic waters, has in recent decades come of interest to both researchers and land management professionals due to its propensity to grow in exceptionally nutrient-poor water, the relative enigma around what leads to its success, and the threat it poses to some water bodies as an invasive. Previous studies have primarily performed in-situ experiments, D. geminata has yet to be successfully raised in-lab where experiments can be conducted. This research examined data and conclusions from over 30 datasets and studies to identify the common conditions necessary for D. geminata growth, identifying what range of conditions the diatom was discovered in and how to optimize that condition for growth and blooms. Conclusions drawn from data and research suggest D. geminata could optimally be grown in an artificial stream with a fast-flowing turbulent water, a summer high water temperature of 15°C, a pH around 8.0-8.5, and chemical levels of 1 µg l-1 soluble reactive phosphorus (SRP), between 10 and 100 mg m-3 total nitrogen, and 0.10 mg l-1 iron. An in-lab experiment with the algae would be immensely helpful to be able to investigate some chemical conditions more precisely, as current experiments are limited by their inability to control every aspect of a river. With in-lab study the physiology of D. geminata and what nutrients are necessary to its growth could be better understood and more solid conclusions could be reached on control strategies for the real world.

The Effect of Ammonium Nitrate Concentration on Escherichia coli Temperature Resistance

Rashmi Raveendran

The project's purpose was to determine the effect of ammonium nitrate concentration on Escherichia coli temperature resistance over time, predicting greater ammonium nitrate increases E.coli growth. Three experimental groups were defined by ammonium nitrate concentration in each agar plate with 0.5 grams/plate, 1.0 grams/plate, and 1.5 grams/plate per plate. The control group had 0.0 grams/plate of ammonium nitrate. Approximately ten plates were run per group. E.coli was plated and incubated at 37□ for 24 hours. After 24 hours, there was no growth on any plate, but the procedure continued by chilling plates at 5□ for a consecutive 24 hours, and then incubating again at 37□ for 24 hours. After 72 hours, no plates had colonies. The hypothesis was not supported as no colonies suggest no effect of ammonium nitrate on E .coli growth both in and out of optimal conditions. The null results are likely due to storage prior to the project. The E.coli was stored at 37□ for three weeks, but the culture can only be stored for 3-5 days at 22□. Higher temperature and storage times kills E.coli culture, likely causing the lack of cell growth.

The effect of sunlight on the salinity of water and the impact of black and white construction paper on the amount of desalinated water.

Irshad Moalim

The purpose of this experiment was to find whether white or black construction paper affected the amount of energy received from the sun and whether or not that affected the amount of water that was desalinated using an apparatus with that color and the salinity of that desalinated water. Desalination plants were researched and the research came to find that they cost a lot of money and were not easy to maintain and therefore not used by many people around the world and that was the reason why this experiment used easy to obtain objects to come with a solution that would benefit everyone. We found that in our experiment, the black construction paper desalinated .8 more milliliters of water than the apparatus with the white construction paper on the bottom. We also found that four out of the ten trials with the black construction paper during the salinity test had a value of 1 mv which was the value of perfect tap water. We came to the conclusion that the amount of energy that was received from the sun was not affected by the black or white construction paper as the amount of water differed in .8 ml and was not statistically significant but we found that the black construction paper was more effective in desalinating the water as this difference between the two groups was statistically significant .

Plant Pool Party

Abby Christman

In my project I wanted to figure out what I could put in the cut flower's water to make it last longer , because the plant´s are always so pretty when they come home from the store. They never last long enough and they die too quickly. I put 3 flowers from the bouquet in each vase of water with a different ingredient in each vase . The results show that the flowers in the water with the flower food had a lifespan that was 106 hours longer on average than the flowers in the plain water. I concluded that the cut flowers lifespan could by increased by using the flower food packet. Now I will make sure to use the flower food instead of throwing it away.

Which Salt Melts Ice Most Efficiently

Tristan Lesher

Sunsets and Sunrises In Twelve Days

Ruby Escobar

Abstract

The purpose of my experiment is to see if the temperature and atmosphere affect the sunset and sunrise color . This experiment's purpose is to help people who want to take great photos with a good background. For this you will need a notebook, a utensil, thermometer, a website telling you the barometer and the dew point, lastly you will need a device to take the photo in the same location and at the same time.

Firstly, in your notebook write in each column time date, dew point, barometer, humidity, and temperature. Then each day Measure these components and write them down in the notebook with a utensil. Make sure you write them in columns. Finally see for yourself if the temperature and atmosphere affects the color of the sunset and sunrise by making a graph of the temperature barometer and dew point then comparing them with the pictures of each day you took.

When the sky turns completely black it's because the sky has reached a specific amount of altitude which is 3500, temperature actually is one of the reasons that keeps the sky from going black because it takes away altitude. Preventing the sky to stay grey at night until it gets colder. The atmosphere moves making the earth face the sun in different directions causing the light rays and light waves to get longer or shorter making the colors of the sunset and sunrise have different colors. In conclusion the atmosphere and temperature do affect the sunset and sunrise .

Impact of Chemicals and Pesticide residue on compost

Sriram Sureshkumar

The key to survival of human civilization is humus. Humus, a dark organic matter forms in soil because of anaerobic composting. It takes nature several hundred years to create humus. Human innovation has led to composting a chemical process that replicates nature's design of decomposition. With the help of composting we can break down organic materials aerobically and create dirt called black gold. This dirt when mixed with soil adds nutrients and enriches soil and after several years of further decomposition turns into humus. Compost helps in plant growth and health. It helps divert organic materials from landfills reducing the emission of greenhouse gases. It also helps in conserving water and reducing the use of chemical fertilizers. The purpose of this project is to understand the impact of chemicals on homemade compost and compost from municipal compost sites used in produce and pollinator gardens in residential areas. A soil test was done to the compost-soil mix used as test samples. The readings were adequate, sufficient, or surplus for pH, potash, phosphorus, and nitrate. Though this is a good indicator that the soil is healthy. It does not show the presence of chemicals or pesticides in the soil mix. The materials used in homemade composts and municipal sites have chemicals and pesticides in them. Grass clippings, food wastes and shredded take out containers all contain chemicals that do not biodegrade. When these composts are used in vegetable gardens or pollinator gardens it results in bioaccumulation in humans and loss of pollinators. When a bioassay was performed on the samples by planting peas which are sensitive to chemicals and pesticides the results were not welcoming. Most of the plants had some level of damage due to exposure to chemicals. The test was performed three times and the results were consistent all the three times. My hypothesis of compost that is homemade or in municipal compost sites is environmentally friendly is not true. It is important to follow the United States Department of Agriculture and Environmental Protection Agencies guideline before using materials treated with chemicals for composting .

Natural Solutions for Dust Reduction

Joseph Willaert

I would like to focus my project on the dust in my home. Dust can come from human skin, pet dander, carpet fibers, furniture, clothes and cooking. Dust is also made up of decomposing insects, lead, arsenic, and even DDT. It is easily inhaled and can make my asthma worse. I also chose dust because it can be seen by the human eye and that means I can measure it.

My research found that plants have a big surface area which can help filter dust in the room and improve air quality. A homemade dust spray using vinegar and essential oils that removes dust and prevents its return. Vinegar is a strong cleaner.

If I use vinegar spray with essential oils, then I will see a reduction of dust in the areas where the products were used, because vinegars contain between 5-8% acetic acid, which has been shown to reduce the growth of bacteria. If I place a large plant (fiddle leaf fig) in a room, then I will see a reduction of dust in the area of the plant, due to the plants large surface area. I think the vinegar spray will have the best result due to the strength of the acetic acid.

Is it nice to add spice to ice?

Liam Murphy

My research question was “Does spicier hot sauce, measured by scoville level, affect the melting rate of ice?” My hypothesis was that sauces with a high scoville level will melt ice at a faster rate. Three trials of the experiment were conducted with four different scoville levels, hot sauces, and one control group. The hot sauce was added to an ice cube and the rate of melting was measured after 30 minutes. Surprisingly, the second mildest hot sauce (Cayenne) performed the best by reducing the ice 47.5%. Habanero sauce, which is the second spiciest, was the third best for reduction of ice. The last place sauce of ice reduction was Ghost Pepper, which was the hottest sauce tested. The hypothesis was not supported, sauces with the highest Scoville levels did not melt the most ice. Interestingly enough, the hottest sauce performed the worst.

Seasonal analysis of human impact on ammonia oxidizing archaea in soil microbial communities within a suburban area

Tessa Lundheim

Human development threatens nitrification and the soil microbial communities that drive it. Ammonia oxidizing archaea (AOA) have recently been discovered to contribute significantly to nitrification, which is essential to life. However, there has been limited research on the effects of human development on AOA, especially in suburban areas over a seasonal period. This study intends to reduce this gap by analyzing soil in suburban locations that have been impacted by human development to different extents over three seasons. Soil samples will be collected every two weeks in the fall and spring and every month in the winter. The soil will be tested for nitrate, nitrite, ammonia, ammonium, and pH levels that may impact AOA. Abundance and diversity of AOA will be identified with 16s rRNA sequencing. The proposed hypothesis is that varying snow cover, pH, and nitrogen levels in soil that is directly impacted by humans will significantly and negatively alter AOA diversity and abundance in comparison to wild control areas.

Using mycoremediation as a treatment technique to reduce heavy metal concentration in model mine effluent

Anna Geldert

Heavy metal pollution from mining poses a major threat both to the environment and to human health. Sulfide-ore mines, such as the Twin Metals' copper-nickel sulfide-ore, are particularly dangerous due to the high reactivity of sulfide which can cause acidification of surrounding aqueous environments. Unfortunately, current treatment methods are limited in that they are costly, inefficient and harmful to the environment. The purpose of this study is to determine whether mycoremediation, or the removal of pollutants using fungi, is an effective method in treating contamination of sulfide-ore heavy metal mines. Three different species of commercially grown fungi will be tested to determine their ability to absorb heavy metals, their effectiveness in reducing the potential environmental damage, and their tolerance to extreme pH levels. If successful, this study would propose one or more of these fungal species as a cost-effective and eco-friendly alternative to conventional heavy metal pollution treatment methods.

Pulling Apart Plastic: Measuring the effectiveness of wax worms, bacteria, and fungus in breaking down biodegradable plastic

Amrit Menon

Ivy Ferstan

Traditional plastics are used throughout our everyday lives, and once they are used, they are thrown away. These plastics are made of polymers, such as polyethylene, which take a long time to break down in the environment. This, along with the amount of plastic waste being thrown away, damages the environment and harms animals. As one solution to this problem, wax worms, bacteria expressing the PETase enzyme, and Aspergillus tubingensis have all been used experimentally to break down traditional plastic, but have not been put into widespread use. Other researchers developed biodegradable plastic as an alternative to traditional plastic. However, outside of specialized industrial composting facilities, studies show that biodegradable plastic does not break down faster than traditional plastic. We wanted to see if combining biodegradable plastics with biological solutions for plastic degradation would be effective. We found that the wax worms did not degrade the biodegradable plastic, while the bacteria expressing the PETase enzyme and Aspergillus tubingensis were able to break it down. This suggests that biodegradable plastics could potentially be broken down by consumers outside of specialized industrial composting facilities.

The Effect of Atmospheric Sulfur Dioxide On Lichen Population

Caitlyn Carroll

Sulfur dioxide is a gaseous compound which is classified as an air pollutant and is converted into sulfates in the atmosphere. Fossil fuel emissions contribute largely to the sulfur dioxide concentration in air, with the highest levels usually present in the eastern United States and residue traveling hundreds of miles in every direction. Exposure to elevated atmospheric sulfur dioxide concentration can cause wheezing, shortness of breath, asthma attacks, and declining general lung function, among other symptoms. Lichen are organisms which contain both fungi and algae coexisting as a single unit and exemplifying traits of mutualistic symbiosis. They also possess bioindicator abilities because of their absorption of the contents of the air instead of acquiring nutrients through soil. Elevated sulfur dioxide levels in the air can be detected by the testing of lichen for deposits of the compound, as well as observing and comparing lichen population and size relative to the data observed in areas of average sulfur dioxide content.
This experiment will design an assay to determine the sulfur dioxide levels of six different geographic areas of one square meter. Subsequent data collection will find the population and size of the lichen present in each area, and thus a correlation between sulfur dioxide levels and lichen prevalence and health can be investigated and a hypothesis accepted or denied. It is predicted that there will be a negative correlation between atmospheric sulfur dioxide concentration and lichen population as well as a negative correlation between sulfur dioxide concentration and lichen size. If the hypotheses are supported, further research on the impact of sulfur dioxide on other organisms should be conducted.

A Breath of Fresh Air: Characterizing changes in atmospheric carbon monoxide in the United States to mitigate climate change

Adithi Rupireddy

Carbon monoxide (CO) is a toxic air pollutant that is emitted as a by-product of combustion. Along with fossil fuel burning, there are additional sources of atmospheric CO from wildfires and from natural sources. While CO does not cause climate change directly, its presence affects the abundance of greenhouse gases such as methane and carbon dioxide . Due to more stringent emission standards, CO emissions have been declining in the U.S., but the rate of this decline is not yet well understood. This is critical information for predicting air quality and how it will change in coming years.

The purpose of this project is to analyze CO levels across the United States, assessing concentrations and rates of change per region. This study utilized publicly-available NOAA data, 2000-present, and applied R-programming language. The findings from this work clearly identify the regional variations and decline trends, both of which are key for predicting future levels. The outcome of this work supports the hypothesis. Next steps include comparing these findings to other locations in the world, along with analyzing other gases, such as methane and carbon dioxide, for regional variation and trends.

U.S. policies on emission standards have been successful in reducing CO pollutants, but current rates are still contributing to climate change challenges. For successful environmental policy to be set, strong and accurate predictive tools are needed. This project is a step toward that goal.

100% Biodegradable Plastics!!! Is it true?

Shagun Shrivastava

100 million tons of plastic are used every year, and by 2050, the world's oceans could contain more plastic than fish! While using plastic is a very easy, portable way that we can get our work done, it can harm our earth in the long run. When I read an article saying that even making plastic can harm our earth and animals, I thought to myself, why don't people use biodegradable plastics that don't linger so long? Soon I got my answer by thinking to myself, people don't know if biodegradable products are sustainable, reliable, or even biodegradable. I decided I would test for myself if the biodegradable products are in fact biodegradable.

First I tested if biodegradable products degrade over the course of 3 months. I put biodegradable and traditional plastic products (plastic trash bag, straw, and spoon) in conditions with light, water, and soil and at the end of the course of 3 months I saw that the biodegradable trash bag was broken down into little pieces while the traditional bag was spotless, which supported my hypothesis. The straw and spoon didn't show any change yet.

Next, I thought, "for the second part of my project, why don't I try to create my own biodegradable plastic discs at home and test them in the same conditions as my first project alongside real buttons, looking for a difference?" At the end of a week the discs I made had started to degrade, supporting my hypothesis.

O2 Is For You! Why Oxygen Is Important To Fish Population

Mac Hoekstra

O2 Is For You!
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Freshwater fish species are going extinct fast! North American Freshwater fish are going extinct at a rate over 800 times the fossil record. This experiment was performed to determine what is a safe level of oxygen for fish to make sure as few species go extinct as possible. The purpose of this experiment was to learn more about oxygen with freshwater fish species. The independent variable was the amount of oxygen in a one gallon tank. The dependent variable was gill movement during a ten second time period.The first hypothesis was if one aerator is used in a one gallon tank, the fish will pump its gills the least amount of times. The central hypothesis for this experiment was that the more oxygen that was added to the tank, the more the fish would pump it's gills. To understand the impact of oxygen with fish the following procedures were performed. Ten second videos were filmed when there were different amounts of oxygen in the tank to measure the amount of times the fish pumps its gills. No matter how much oxygen was in the tank, the fish pumped its gills around 22 times every ten seconds. This science fair project was conducted to help the DNR better understand oxygen with fish. Even though this project did not show much change in the data, the project still met the objectives.

Can Machine Learning Predict Hurricane Damage in a Changing Climate?

Quinn Hughes

Tyler Clair

Hurricanes are storms that occur near the equator. They get their energy from the heat from the oceans. Hurricanes are classified by wind speed, there are 5 categories of hurricanes. Ocean temperatures are rising due to global warming, which could mean that hurricanes are getting more severe. We wanted to use linear regression to predict how frequent they will occur, how severe they will be and how long they will be. We used a random number generator to separate the data into a training set (70%) and a validation set (30%), we used the training set to fit the model and the validation set will be used for validating the fitted model. We discovered that there have been approximately 1.48 more hurricanes per decade since 1850. We then found that water temperatures in the Gulf of Mexico are increasing by 0.024 degrees Celsius per year. We also found out that on average the wind speed have been increasing by 0.023 knots per year since 1850. Another discovery was that the length of hurricanes is increasing by 0.0456 days per year since 1850. Using our final model we can predict that in 2050 the average wind speed will be 77 +/- 38 knots. Our predictions show that if current trends continue over the next 100 years, the average hurricane strength would approach the category 5 level, which would be devastating to the Gulf Coast of the United States in terms of fatalities and economic impact.

SPYGLASS: Eye-controlled camera glasses

Levi Mellin

Nikolas Liepins

As the world turns to wearable technology, multiple companies have tried their hands at smart glasses. However, no one has yet developed a product that strikes the balance between features and fashion. The sleekest smart glasses have the least advanced technology, while the most advanced glasses are bulky, unattractive, and unfashionable. Further, there is no comprehensive hands-free system yet on the market. Spyglass (shown in Figure 1) addresses the current market's limitations by allowing users to control a camera with their eyes. Utilizing a QTR-1A reflectance sensor, Spyglass detects specific eye gestures and reacts accordingly, allowing users to activate the on-board camera and automatically send an image via email without lifting a finger. Behind the scenes, reflectance sensors detect when users move their eyes, while an Arduino Mini processes the signal, which activates the ESP-32 camera. Spyglass can already take and send photos via email, and other features under development include capturing video and streaming to a remote location.

Improved Wearable Device for Drowning Detection System

Grace Roemig

The risk of drowning poses a significant threat to all swimmers, especially children and families in low socioeconomic classes. Drowning-related injuries and deaths account for 7% of injury-related deaths in the world (World Health Organization, 2020). The most drowning incidents occur in pools, followed by lakes, rivers, streams, storm drains, and bathtubs (Layon, 2009).

Some researchers have developed drowning detection systems to prevent drowning situations. Existing systems rely on signals being blocked by the water or use cameras or both, and tend to be inaccurate due to an inability to account for variation in swimming ability as well as overlapping signals causing false alarms (Sport England, 2011).

This research will develop a new drowning detection system that uses sensors to track user information in order to more accurately detect drowning situations without causing false alarms. A previous study done by a Minnetonka Research alum began researching this detection system by designing a waterproof case for the wearable device prototype and developing a simplified algorithm to track output from one of three sensors at a time, which would then be sent to a hub on the side of the pool to alert others to the drowning situation. This research will replicate those steps, then write an algorithm in Arduino to monitor information from all sensors at once, as well as add sensors to detect light levels, location, heart rate and blood oxygen levels to further increase the accuracy of the drowning detection. The full system will include a wearable device made up of a Feather Arduino microcontroller with all the sensors held within a waterproof case , as well as another Arduino microcontroller on the side of the pool as the device hub.

Development of an affordable ultrasonic array for recording and analysis

Zachary Levy

Ultrasound is useful for a broad range of scientific, engineering, and educational purposes, such as for studying bioacoustics and creating ultrasonic equipment. The study aims to develop a low cost ultrasonic array capable of acting as a recording and analysis device by building on the single transducer device created by Holcomb, Schneider, and Briggs (2015). While such devices are available commercially, they are typically expensive and therefore inaccessible for many use cases. Ultrasonic transducers will be selected and arranged to optimize the beam pattern of the device, which will consist of transducers, an amplifier, high pass and low pass filters, and a microcontroller. A software program will be written in python to derive the frequency spectrum of the ultrasonic signal and allow for delay and sum beamforming. The device will be tested by measuring the beam pattern of the array and determining its accuracy at different frequencies .

Salt and Paper: Using Papermaking Techniques to Engineer a Plant-Based Piezoelectric Transducer with Rochelle Salt to Generate a Resilient, Eco-Friendly Source of Voltage

Maggie Banks

This experiment focused on creating an eco-friendly transducer out of paper-like constructs and Rochelle salt (RS). First, manufactured filter paper, oak leaves, and cornhusks were tested. Filter paper was cut into rectangles and squares, and each material was tested with and without RS. Electrode placement was also tested. Square paper with RS produced the highest voltage on average (780mV). Voltages generally increased when RS was added. The brittleness of corn was prohibitive of taking samples.

Another experiment focused on creating a paper-like structure out of leaves and cornhusks. With this technique, corn created a more solid structure than leaves. The deviation for the corn was 120mV, with a 150mV average. Because of a low signal-to-noise ratio, a histogram was used to analyze the distribution. Leaf data was not not normal, with the majority of the data points distributed 80mV-120mV, with three outliers. Corn data was less skewed, with the majority of data 120mV-160mV. Therefore, the corn appears to deliver a higher voltage. Longitudinally placed electrodes delivered more voltage and were used moving forward.

Finally, paper was supersaturated with RS. Voltages were consistently larger than previously. Once again, the leaves had a large deviation (average of 280mV, deviation of 290mV, but with an outlier at 2000mV. Corn had no major outliers and a much smaller range. Though the leaf average was higher, the deviation was so high the results proved inconclusive. Leaves were also more structurally delicate. Corn was selected as the best material for a biodegradable piezoelectric transducer, producing 260mV.

Solar Powered Phone Charger

Grant Pilgrim

For this project I studied different types of solar powered chargers and then built my own . An energy bank solar charger uses the solar panel to charge the battery and the battery stores the power for later. With a direct solar charger, the power from the solar panel goes straight to the device. For my charger I selected a Minty Boost set because it is small, it is very portable, and it is a battery bank charger so it can store power for later. The total price for all components was $82.55 including tax and shipping. Everything fits inside an Altoids case and it charged an iPhone from 50% to 100% in about 2 hours.

Citrus Battery

Chipo Chinokoro

The question of this experiment is “Citrus Battery.” In this experiment we use a variety of fruits to compose the voltmeter reading voltage, and current time electricity was produced. A voltmeter is an instrument for measuring electric potential in volts. An electric current can flow through the wires in one direction through the zinc or the copper terminal, also referred to as the anode and the cathode. We always use batteries to get electric sources but are harmful and hard to compose . So, instead of us going the hard way, we might as well just use fruits/vegetables. The fruits/vegetables will produce electricity that convert from chemical energy to electrical energy. Next, we use copper and zinc as electrodes. The redox reaction happens when two electrodes (Zinc and copper) connect to the fruits/vegetables. The Zinc will undergo an oxidation process while copper undergoes a reduction process. Then electrons will move from anode (Zinc electrode) to cathode (copper electrode) and cause the volt number to increase. At the end of this experiment we expect that acid is needed to contribute to generating electricity. In this project, we used different types of fruits as a function of electrolytes that can convert chemical energy to electrical energy. The voltmeter is used to indicate if the fruit cell is producing any voltage.

Does the Temperature of a Battery Affect How Long It Lasts?

Edwin Portillo

My experiment is “Does the Temperature of a Battery Affect How Long and Lasts.” Why I choose this topic is because I wanted to know if temperature affects the battery on how long it last. That way it you would get the most out of your battery.

For each three batteries I will put one in the cold, one heat, one room temperature. After a two hours I will get a multimeter to check how much power each one has. Then I will write down in my notebook. Then I will put each group in a different flash light and every two hours I will take out each battery. Then I will record how much power each one has.

For my room temperature group like a regular battery it is depleting slowly. The warm group really shocked me because my warm group depleted the least which I did not expect. My cold group I thought would deplete the slowest but that was not the case.

In my project my question is “Does the temperature of battery affect how long it lasts?” My results did not support my hypothesis. This was because in my hypothesis I said that the warm group was going to depleted the least. I said that the cold group was going to be the one that mostly depletes. Which did not happen in my results.

Easy Piezy Electricity

Trisha Samba

Approximately 75% of the United States' greenhouse gas emissions originate from burning fossil fuels , significantly contributing to global warming. The nation's heavy reliance on fossil fuels poses major concerns for energy security in the future. However, current popular energy alternatives, such as solar and wind power, have geographical and monetary restrictions. Thus, the development of a portable and inexpensive, clean energy source is crucial.

Through research, I constructed sustainable, electricity-producing footwear. The readily accessible shoes generate electricity using motion and body heat through piezoelectricity and thermoelectricity, respectively. Piezoelectricity utilizes mechanical stress to create a charge imbalance and therefore voltage, while thermoelectricity—through the Seebeck effect—contains semiconductors that cause a buildup of charges and therefore voltage.

Two electricity-producing shoes were created. The first shoe was created by inserting piezoelectric discs in a 3D printed sole, in areas of pressure, soldering the discs in a parallel circuit, and connecting them to a multimeter. The second shoe was created by inserting heatsinks and thermoelectric peltiers into the base of the shoe, and also soldering the discs in a parallel circuit, and connecting them to a multimeter. The shoes will be tested by walking outside for ten minutes and comparing the average voltage of each shoe. It is hypothesized that the shoes that generate electricity using piezoelectric discs will produce the most voltage. Results are yet to be determined.

The development of this sustainable electricity-producing footwear will help combat the growth of global greenhouse gas emissions and set an economic precedent for future energy alternatives.

Pathway to a Sustainable Future: Economic and technical feasibility of hydrothermal carbonization (HTC) processing plants

Kyla Fung

In order to combat climate change and achieve global sustainability, recycling waste and reducing our use of fossil fuels is crucial as we continue moving forward. Hydrothermal carbonization (HTC), a fairly new waste-to-energy conversion method, is seen as an efficient solution for both of these problems, having the ability to avoid the cost of treating waste by conventional means and recovering energy in the form of hydrochar (a renewable energy source with a heating value similar to coal). However, HTC processes are still yet to be more widely implemented on a commercial scale. Currently, most existing HTC plants are located in Europe, with some in China and few elsewhere (Bevan 2020).
The purpose of this study is to create a business model for commercial-scale HTC plants that process waste and generate economically and environmentally sellable products. This research aims to specifically assess the economic and technical feasibility for HTC plants in the United States, due to the lack of existing HTC plants and high waste generation in the U.S. Literature-based research, investigation of industrial-scale HTC plants, and discussion with industry experts will be used to develop a hypothetical HTC operation in Minnesota and assess the feasibility of such an operation. The proposed hypothesis is that implementing HTC plants can be more economically feasible and environmentally effective for converting waste to energy as an alternative to existing methods. Overall, discovering the financial and technical feasibility of HTC plants will aid in its future application on a global scale.

Comparison of energy output levels of the upper Mississippi River sediment using sediment microbial fuel cells

Grace Kaung

Sediment microbial fuel cells (SMFCs) are a type of membrane-less microbial fuel cell that produces electrical energy from the chemical energy in organic matter found within sediment. SMFCs have been investigated as an alternative energy source, as well as a method of bioremediation. However, the low power output has prevented SMFCs from being used in practical applications, therefore it's important to find the optimal circumstances to maximize energy output levels . The focus of this study is to use the MudWatt microbial fuel cell to create a SMFC that can compare the electrical current levels between urban and rural sections of the Mississippi River within Minnesota. The proposed hypothesis is that sediment samples from urban sections will produce a higher current due to the larger quantities of organic matter within the sediment. Furthermore, the microbes within the sediment will be identified to determine how different species of microorganisms affect energy output levels.

Growing Fuel: Enhancing Phytoplankton Growth with Ferrous Sulfate to Reduce the Cost of Biofuel

Benjamin Rex

Grayson Roberts

Due to rising atmospheric carbon dioxide concentrations stemming from the burning of fossil fuels, global temperatures are rising at an alarming rate. Global CO2 emissions must be reduced to prevent the worst effects of climate change. Algal biofuel is a promising alternative to traditional fuels because phytoplankton, the source of our biofuel, remove CO2 from the atmosphere during photosynthesis. However, biofuel is currently too expensive to compete economically with fossil fuels.

The goal of our project was to find ways to reduce the production cost of biofuel to make it more competitive. Ferrous sulfate has previously been found to increase phytoplankton biomass production, so we examined whether the enhanced growth was worth the added cost of iron. We designed and built a bioreactor to test the effect of increasing concentrations of iron on phytoplankton growth.

In all three trials, biomass output increased from lower to higher iron concentrations.. In two out of three trials, biomass output decreased at concentrations higher than 0.555 μM. The combined average biomass for all three trials was highest with an iron concentration of 0.555 μM. However, due to the high variability between trials, the average differences between supplementation levels did not reach statistical significance. The amount of iron that produced growth enhancement was so little that the cost was essentially negligible. Finally, ethanol was used to extract lipids from the phytoplankton at a lipid yield rate of 20%, similar to other biofuel studies.

Picking metal up like nothing ; Will wire winding affect the strength of an electromagnet?

Brady Peterson

Picking metal up like nothing ; Will wire winding affect the strength of an electromagnet?
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How does the number of turns around the electromagnet affect how strong it is? The purpose of this experiment is to see if more turns around the electromagnet would affect its strength and to better understand the electromagnet 's technology. The independent variable of this experiment is the number of turns of the wire around the electromagnet. The dependent variable was the strength of the electromagnet. Four experiments were performed. For each of these experiments, 12 gauge wire and 14 gauge wire was tested. For experiment 1 the test was with 12 gauge wire 18 turns around the 3 inch bolt and the average was 10.7 washers picked up. For Experiment 2 the test was with 12 gauge wire 15 turns around the bolt and the average was 6.9 washers picked up. For experiment 3 the test was with 12 wire 10 turns around the bolt and the average was 3.3 washers picked up. For experiment 412 gauge wire was tested and 5 turns around the bolt and the average was 1.6 washers picked up. And for experiment 5 14 gauge wire was tested and10 turns around the bolt and the average was 1.8 washers picked up. In conclusion, each of the different bolts and wires had a different output. So More turns around the bolt are more effective.

A Comparison of Three Wing Configurations at Different Heights in Ground Effect

William Anderson

A comparison of the three main configurations of ground effect vehicles (tandem-wing, reverse delta, and ekranoplan) was conducted to determine which is most efficient. Lift-to-drag ratio was used as the metric for comparing efficiency, and was measured using a Jetstream 500 desktop wind tunnel and small 3D-printed models. Measurements of lift, drag, and lift-to-drag ratio were conducted at different ride heights. It was hypothesized that ground effect would be observed, and that the reverse-delta configuration would be most efficient. Results indicated that while the effect of ride height on drag was consistent with the hypothesis for all three models, suggesting ground effect, the effect of ride height on lift was extraordinarily inconsistent, though the reverse delta was slightly more efficient than the other two models at three of the five ride heights (0%, 50%, and 75% of mean aerodynamic chord). This inconsistency was possibly due to inaccurate measurements of angle of attack during trials, so a second, improved trial with a modified adjustable bracket was conducted.This new trial provided equally inconsistent results, revealing that consistently controlling the angle of attack was not possible with the new bracket either. As such, the research question has not been answered, and this method of studying ground effect is most likely impractical. Instead, computational fluid dynamics software appears to be the most effective strategy for studying ground effect.

RK Divides

Kerubo Mekenye

Ruthie Gray

In our project, we decided to design 3D printed bowls with dividers that contain enough food storage for the desired food item/(s). We've come to the realization that at times you want multiple food groups inside a bowl . However, because of the limited space, you aren't allowed to do so. Our hypothesis states that: If we create bowls with dividers, then packing different foods becomes easier, because you are able to fit numerous things inside the bowl versus having to take each food separately. First, we started by interviewing 10 people ranging from the ages of children (9-15 years old) to adults (44-50 years old). Our main questions were asking their opinions on whether or not they think having bowls with dividers would be beneficial towards their food storage needs, showing them our designs and asking if they believe it would be successful, and lastly, asking them the possible downsides of this project. In addition, we also asked the bonus questions of whether or not they would use our product, and if they've had any negative or positive experiences with other lunch compartments. As well as asking what foods they would use. In conclusion, we received an overall positive outcome from every one of our interviewees. The main feedback was that people believed our project would fulfill their needs and would prevent the issue of foods mixing with others. Our project will benefit people of all ages, and we are so excited to begin printing our bowls and dividers!!

The Engineering Behind Theme Park Rides: Creating and Coding a Model Theme Park Ride

Nickolas Zander

The purpose of this engineering design project is to create a model theme park log ride that mimics the real-life ride and is safe. Safety is an important aspect of theme park rides. My goal is to recreate the ride that I choose while learning about the engineering mechanics behind the ride and how it keeps riders safe. First, I brainstormed various rides that I thought could work and chose which one I would build based on its feasibility. My model will have five main mechanical aspects, being the waterway, lift hills, ride vehicles, sensors, and gates. My waterway is a channel of water that is moved by pumps. This waterway is where the boats are located, which will move past sensors. These sensors will trigger gates so that the boats can stop, preventing collisions. The lift hills will act as connectors between the two segments of my ride, being controlled by motors. I ran numerous tests on the design and coding of each component throughout the build to determine if they were working properly. One of the largest challenges that I encountered was in relation to the water channels, with them not being uniform. I hope to optimize these in a future build due to them not being efficient. I enjoyed learning about the many components and mechanics that go into engineering a theme park ride.

Water Balloon Launcher

Sarah Baldauff

Purpose
The purpose of this research project was to build an inexpensive Water Balloon Launcher that could be held , be mobile, and launch water balloons automatically using air pressure as a propellant. The launcher should be capable of being refilled quickly.

Procedure
The procedure that we followed for this project was to research existing products, and then based upon that research look for a new approach for building a cost-effective Water Balloon Launcher. Based upon research we conducted, we then then created an initial set of designs, and picked the most promising design from those candidates. Once we had an initial design, we laid out plans to build the device and test it. We then built the device according to plan and made a couple modifications in order to ensure the launcher worked well. Finally, we conducted pressure and distancing testing, along with water balloon size and distance testing.

Observations/Data/Results
The water balloon launcher had four parts to it: the air inlet, the trigger, the air pressure chamber and the barrel. In order to use the Water Balloon Launcher we had to perform certain steps before a launch. These steps included, loading the air pressure chamber with compressed air, loading the barrel with a little water for lubrication, adding a water balloon to the barrel, pulling the trigger, and then measuring the distance travelled by the balloon.
The first set of tests were based upon the amount of pressure placed in the air pressure chamber. When loading the launcher with air, we measured the resulting pressure with a tire pressure gauge. We expected at various levels of pressure, the Water Balloon launcher we go increasing distances (as the pressure increased.) As it turns out, this wasn't exactly the case. The following is a sampling of the data which we gathered:

Pressure (IV)	Distance (DV)
25 PSI	30 ft
40 PSI	65 ft
60 PSI	45 ft

As the table shows, more pressure did not always mean greater distances. We concluded that more research is needed into other variables in the system. Our current hypothesis is that the angle that the launcher is inclined at when shooting may also impact the distance traveled by the balloons launched. This will be an item which we investigate in further research in a subsequent study. There may also be other variables which need to be investigated such as temperature, amount of water used as lubricant, and others.
The second set of tests which we performed were focused on water balloon size and distance traveled by the balloon. With this set of tests, the data seemed to match closer to our expectations. When launching smaller sized balloons, the balloons did seem to go farther. Following is a sampling of the results of the water balloon size testing:

DiameterOf Balloon (IV) (Control Variable)	Air Pressure Distance
2"	60 PSI 10 ft
1.5"	60 PSI 50 ft

Additionally, as we used the Water Balloon Launcher, we found some issues which we addressed. Particularly, the tire valve stem used in the construction of the Water Balloon Launcher, was not held in place by anything other than pressure and a rubber notch. While, this did work for a time, eventually it fell inside the Water Balloon Launcher. We had to take the launcher apart, and glue it into place using super glue. After this point, the value stem / air inlet, never moved or was problematic. Additionally, in order to ensure we had access to the air inlet, we added a threaded end cap at the rear of the launcher so we had easy access to it in case of future problems.

In conclusion, the Water Balloon Launcher was a solid design, but does need some additional testing to determine how best to pressurize for launching, and also best use in the future. In a future study we will add additional variables to the testing to see what we can additionally learn about how to best use the current design as well as improve upon it.

Redesigning New Life Disc Golf Course

Joshua Butler

The purpose of this project is to improve the existing New Life Disc Golf course and to add publicity to the school. The improvements made on hole 2 make the hole a more technical shot and improve safety for other players by eliminating the threat of crossing fairways. The existing course has repetitive shots and some some shots would cross fairways, increasing the danger. I looked at the existing New Life Disc Golf map and chose a hole that had safety issues and a problem of losing discs. I chose to make improvements to hole 2 because of these factors and also to add a technical hyzer shot (a shot that goes up and dives down to the left). I, in the time that I had, was able to make the adjustement to hole 2 by moving the long tee of hole 2 behind the short tee eliminating the crossing fairways and moving the basket to the left side of a tree which makes it more of a technical shot. The final result was a success because the improvements added safety and a technical shot to the course. Improving the course should add publicity to the school and adds a challenge for the New Life Disc Golf Team to play and for others in the community. The initial objective was met before the deadline.

Homework Helper

Ella Borner

Rice Pack Holder

Audryn Hegewald

I created a Rice Pack Holder for my engineering project. I wanted to create a Rice Pack Holder because from a young age I had chronic knee pain. I tested the holder on two family members and myself and had positive feedback. To create the Rice Pack Holder, it took me 20 hours and about $15-20. I used duck clothe as my main material and used my sewing machine to create the holder. Thank you for your consideration.

AmbidextriCut

Olivia Farina

I found that because I am left handed, when I went to use my paper cutter, it was frustrating that I couldn't use it properly. I decided to make a paper cutter that both left and right-handed people could use . I built the blade in a way that it was ambidextrous, functional, and simple to use/ understand.

A.L.M.E. Assistive Lifting Machine for Elders: Engineering a solution to fall-recovery-related injuries in seniors and caregivers

George Richards

William Sweeney

Falls are the leading cause of injury in the United States amongst those aged 65 or older as every second an older person falls. When a fallen individual is left on the floor for a prolonged period of time, they are at risk of further injury. Additionally, caregivers are at a risk of injury from lifting fallen seniors. Currently, there are no devices designed to lift a fallen individual from flat on the ground, so we set out to create one. The device consisted of a frame, ramp, and hydraulic system. The hydraulic system consisted of a 2500 PSI hydraulic cylinder and two hand-operated 350cc hydraulic fluid reservoirs. This allows the user to simply move the hand pump back and forth to raise the ramp, thus lifting the fallen person off of the ground.

We tested the maneuverability of the device, the height the ramp could get off of the ground, and the time to reach 100 pumps of the hand pump, all as weight increased. As weight increased for the three tests, the maneuverability decreased, but the cart was still able to complete a simple obstacle course; the ramp height decreased but still cleared the floor; and the hand pump didn't become more challenging to use. Finally, we calculated the maximum weight the device could lift before breaking to be 250 lbs.

This device represents an effective, user-friendly, and inexpensive solution to safely lifting up fallen seniors with the potential to reduce injuries to both seniors and their caregivers.

Designing a more practical and efficient multipurpose autonomous VTOL delivery drone

Bryce Rega

Unmanned Autonomous Vehicles (UAVs) have been used for commercial, recreational, and industrial purposes. Multiple companies have designed and even constructed their own drones for their own purposes. A particularly interesting area of this is the delivery market as drone delivery brings many benefits. UAVs don't require the fuel that trucks do, they don't require drivers if they operate autonomously, and they do not have to sit in traffic and can travel much farther. While creating these autonomous vehicles, companies have run into different design and engineering challenges. Issues with cost effectiveness, payload capacity, range, and other important factors have risen.

The purpose of this research as a whole and the collection of its experiments is to design and produce a UAV that is effective in every way and can be used by multiple companies, organizations, and industries to meet its needs as the future of UAVs continues to grow. In order to do this, multiple experiments need to be conducted on different parts and systems of the UAV to ensure that each part is as effective and efficient as can be and that it coordinates well with the other parts and systems of the UAV. These experiments will first be done on an expendable test vehicle before they are eventually moved onto a working prototype. Different tests and experiments will be conducted on the UAV as a whole to ensure that it can withstand different environments, users, and purposes in order for the research to meet its goal of creating an efficient and effective UAV for multiple uses.

CFD and wind tunnel analysis of variable cant angle winglets for aircraft control and multiphase drag reduction

Rohan Parnerkar

This research will perform computational fluid dynamics (CFD) and wind tunnel testing to determine the applications of variable cant angle winglets for multiphase drag reduction. The testing methodology will focus on determining which winglet cant angles are most effective at various flight conditions. Additionally, this study will use wind tunnel testing to determine the range of control moments able to be generated by the asymmetric canting of variable cant angle winglets.

Bridging the Gap

Levi Abbring

This experiment was chosen and performed to determine the factors that contribute to suspension bridge's strength . In the sag ratio strength test, the independent variable was sag ratio and the dependent variable was tension. In the tower test, the independent variables were the tower type and compression. The dependent variable was the tower breaking point. My hypotheses were for the sag ratio test: If the bridge has a lower sag ratio, it will support more tension than other percentages. The median sag ratio will support the most tension. The null hypothesis was that the sag ratio will have no effect on the tension supported. For the tower test, the hypothesis was that Figure 2 will support the most weight, Figure 1 will bend the most. And the null hypothesis was that all figures will support the same weight. In the sag ratio experiment a cable was draped between two sawhorses, then measured the sag ratio of, put 35 pounds on it, and measured the tension. In the tower test, towers were built and mounted onto a sawhorse, and a ratchet strap was secured over them so pressure could be increased incrementally until tower failure resulted. The results of these experiments showed the larger sag ratio the less tension and Figure 3 is strongest. This will help engineers know how to build an efficient bridge in a third world country with limited resources.

Gliding Through the Sky. How Stabilizers Affect Distance

Thomas Rewey

Gliding Through the Sky: How Stabilizers Affect Distance
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Aerodynamic gliders are truly an amazing way of flying. The purpose of this experiment was to find out the most functional glider stabilizer. The independent variable in the experiment was the stabilizer. The dependent variable was the flight distance. The controlled variable was the glider and the launcher. The hypothesis for this experiment was that stabilizer one would fly the best. To understand the impact of stabilizers on gliders, the following procedures were performed. A glider was constructed out of foam board along with three different stabilizers. The glider was tested by launching it off of a launcher. The data was recorded by setting a tape measure from the launcher to the end of the tape measure. Each of the three stabilizer designs was tested ten times each and their distances recorded. The data was based on how many meters each stabilizer flew. The results for the test were stabilizer one flew the furthest in the tests however it wasn't significantly farther. Overall, there were no notable differences between the three stabilizers.

Treatment of Acid Mine Drainage with Desulfovibrio desulfuricans

Jack Hlavka

Acid mine drainage poses a major risk to the nearby ecosystems as the accompanying low pH and high metal content kill plants. Sulfate-reducing bacteria have the potential to remediate this drainage, but the effect of their amelioration on plants had not yet been tested. Simulated acid mine drainage was created with diluted sulfuric acid and dissolved iron, copper, and zinc. Desulfovibrio desulfuricans was cultivated in an anaerobic environment on agar with the simulated drainage for treatment. Brassica rapa seeds grown in untreated drainage had a germination rate of 66% and a sprouting rate of 0%, while seeds in treated drainage had a germination rate of 98% and a sprouting rate of 19%. The treatment method increased the germination rate (X^2 (1, N = 100) = 34.68, $p < 0.00001$) and the sprouting rate (X^2 (1, N = 100) = 19.02, $p = 0.000013$). The germination rate in treated drainage was statistically no different than in water (X^2 (1, N = 100) = 2.02, $p = 0.155$), though the 96% sprouting rate in water was higher than in treated drainage (X^2 (1, N = 100) = 121.32, $p < 0.00001$). While the treatment did not remove all harmful effects, the number of seeds that were able to germinate in treated drainage was statistically indistinguishable from the number in water. The results indicate that treatment with sulfate-reducing bacteria, specifically Desulfovibrio desulfuricans, has the potential to be extremely effective at remediating acid mine drainage.

Can Using Magnets as a Growth Stimulant Overcome Poor Plant Growing Conditions?

Will Cunningham

The purpose of my experiment was to find out if using magnets as a growth stimulant for plants could overcome poor growing conditions. I grew 18 plants divided into 6 groups of 3 plants. The 6 groups consisted of a control group, a control group with magnets, a low water group, a low water group with magnets, a low light group, and a low light group with magnets. Around half way through my experiment, I realized that I was giving my plants too much water and drowning them. This benefited both of the low water groups resulting in those two groups having the fastest growing plants.

Effect of solar panel angles on voltage output

Deq Jama

The purpose of this experiment was to determine if different angles of a solar panel affect the voltage output . When testing this, the angle of the solar panel was the main factor of which was being researched. It showed that the different angles of the solar panel affected the voltage outcomes, each time it was tested. The experiment supported other findings which were that the 35 and 45 degree angle would give me the highest voltage outcome. When the solar panel was used at the 35 and 45 degree angle it would get the most out of the sun's light. The solar panel is made up of silicon, when sunlight hits the solar panel, electrons in the silicon begin to move, that causes a flow of electricity and that is a DC current. It was concluded that the hypothesis, " Which angle of a solar panel would have the highest voltage outcome." was supported in the experiment. The data was proven statistically significant when tested at the 0.05 significance and a critical value of . The experiment had 9 different angles. Each angle would be faced towards the sun at its given angle. The outcome would be written down in volts in the data table.

Which Animal Manure Fire lasts the Longest?

Minhphuong Le

I was wondering which animal manure fire lasts the longest. This was basically to kind of see if there was another way to use animal manure for a productive cause. I knew that animal manure could ignite a fire so I just added a little touch to it to make this project a little more interesting.

Recycled Material Floating Bio-Habitat

Lillie Wagner

Implementing an Ecological, Self Sustaining Home Incorporated with the Natural Surroundings

Aidan Rich

Testing the Waters: Engineering an Innovative Method of Water Health Analysis Year II

John Cardwell

Natural and anthropogenic sources pollute lakes and rivers worldwide, endangering freshwater supplies. To address water-related problems, physical sampling and data collection are required. Current methods of manual water quality evaluation are time-inefficient and expensive. The focus of this research was to design a remotely operated system to monitor the health of lakes and rivers. It consisted of two parts: 1) a quadcopter drone to collect aerial imagery, and 2) a remote-controlled watercraft to collect physical samples and electronic data.
Aerial photos captured using a DJI Mavic Air 2 drone were analyzed for color, and drone video was used to 3D render topographic maps. The drone was also used to document progression of an algae bloom. A portable remote-controlled watercraft was fitted with a water-sampling system. This system utilized 1) vacutainers (traditionally used for blood collection); 2) an attachment chain fitted with 3D printed vacutainer retention; and 3) a linear actuator articulating a needle to puncture. A prototype vacutainer sampling system was constructed in year one, but the design was refined in multiple areas: 1) the mounting plate was completely redesigned; 2) a second plate was added to properly tension the chain; and 3) a more effective puncture mechanism was implemented.
To the authors' knowledge, the remote-controlled mini-watercraft engineered in this study is the first to employ vacutainers in water collection. When ultimately operated in concert, the mini-watercraft/drone system could gather detailed, comprehensive data on physical and chemical aspects of a body of water, facilitating economical management of limited freshwater supplies.

Purification with Desalination

Mercy March

Purification with Desalination: Distillation vs. Reverse Osmosis
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The earth’s water consists of 96% of saltwater and 2.5% of freshwater. If people can turn the saltwater into freshwater effectively and efficiently, desalination can contribute to solving earth’s water crisis. This experiment was performed to determine if turning saltwater into freshwater is effective and efficient. The purpose of this experiment was to compare distillation and reverse osmosis. The independent variable is the amount of salt and the dependent variable is the refractometer reading. Reverse osmosis will be more efficient than distillation. The amount of salt at the start of the distillation process will have no impact on the purity of the water. For the distillation part of this experiment five cups of water was mixed with two or three teaspoons of salt. Using the sun's heat as energy, the water evaporates and is collected, leaving the bacteria, minerals and salt behind. For the reverse osmosis part of this experiment water was put through a reverse osmosis filter and then tested. The result of this experiment showed that the amount of salt in the water did not impact the purity of the water and that distillation and reverse osmosis had the same results at the end but reverse osmosis was faster than distillation. The data from this experiment showed that after the desalination process, the results for reverse osmosis and distillation were both at zero parts per thousand of salt. This experiment is meant to show how desalination works and determine if these methods are effective and efficient.

Incorporation of Recycled Plastics In Road Materials

Ben Chen

The purpose of this project is to test the feasibility of incorporating recycled plastics into concrete as a roadway material. In the US, over $170 billion is spent annually on highway construction and maintenance; at the same time, over 14.5 million tons of plastics are discarded as municipal solid waste. Robust combinations of conventional and recycled materials for roadway construction are potentially groundbreaking in cost and environmental benefit. Plastics have properties that may be favorable for infrastructure applications, such as resistance to shock, chemicals, and corrosion; however, research in this field is minimal, consisting primarily of incorporating plastic into hot asphalt. For this study, different compositions of concrete-plastic mixtures were made: 0%, 25%, and 50% concentrations of HDPE (High-density polyethylene) and TPE (Thermoplastic elastomer), and were made subject to a stress-fracture test (using a Vernier Material Tester). An impact tester was also developed for qualitative assessment of strength and condition samples for water permeability tests. These mixtures were also heat-treated to examine potential effects on material properties. The results determined that pure concrete was the strongest material tested and was impermeable to water up to multiple high-intensity impacts. Although this was somewhat expected, the heat-treated HDPE 50% samples performed most closely to conventional concrete in the strength test, most likely due to the plastic pellets' inter-melting. Other than the 50% HDPE heat-treated concrete sample, all other mixtures, including all of the TPE samples, had much lower strength, with the heat-treated TPE 50% mixture being the weakest. In terms of water permeability, all of the concrete samples with recycled plastics, even those that were heat-treated, allowed water to flow through without impact conditioning. Based on this study, the inclusion of recycled plastics into concrete, particularly HDPE, is potentially viable for use in roadway construction. In particular, a heat-treated 50% HDPE concrete mix could be an environmentally friendly, water-permeable alternative for regular concrete with little compromise to strength. Such a construction could be useful for situations where water pooling on the road surface is undesirable for safety (hydroplaning) or structural (bridge decks) perspective. Although this data seems promising, further research is required to even begin the processes of actually incorporating recycled plastics into concrete.

Grip the Greatness? Do Football Gloves really help you catch better then bare hands?

Bud Brondum

The purpose of my experiment was to figure out if Cutters football gloves are better than a generic brand of gloves or bare hands, especially in wet and dry conditions. I became interested in this topic because I have been playing football for years and have always wondered what the purpose of football gloves are. I conducted an experiment in which 4 test subjects caught balls using Cutters gloves, Finger Ten gloves, and bare hands in different weather conditions. My results showed that the Finger Ten gloves performed the best in both wet and dry conditions. Cutters slogan is “Grip the Greatness” and although they did help my subjects catch better than bare handed, they were not the best. This could have been due to the better fit of the Finger Ten gloves to my subjects. If you are a football player thinking about purchasing a pair of gloves, my research along with this experiment supports the use of gloves, but get some that feel comfortable and fit well to improve your catching accuracy.

Which fishing line holds the most weight; testing braid, mono, and fluorocarbon lines.

Will Guion

The purpose of my experiment is to see what line (fluorocarbon, braid, or monofilament) can hold the most weight. I also wanted to see if fishing lines could really hold the weight they advertise. I chose this experiment because I really like fishing and I was interested in what would happen. I built a wooden rack in my garage that could hold buckets of sand. I hung the buckets by the fishing lines. I added sand to buckets one cup at a time. When the line snapped, I weighed the bucket onto the scale and recorded the weight. I repeated two more times. In the end, the mono line held the least weight with an average of 7.8 pounds, the braid held an average of 11.2 pounds and the fluorocarbon line held an average of 11.3 pounds. I was correct in my hypothesis that the mono line would hold the least amount of weight but incorrect with guessing the braid line would hold the most weight.

Basketball and Noise

Hamza Nure

Wood vs Composite Hockey Sticks

Liam McGlynn

The purpose of this experiment is to find out which stick to use in hockey. This experiment will determine which stick produces the fastest puck speed. Others have done this experiment and found out the answer. They found that composite sticks are a better stick to use in a hockey game because of flex, a custom curve and is light weighted. But conversely wood is better to use at a young age and is better for passing. Others have said that a composite stick will be faster to shoot with. Most players agree with that.

The procedure of this experiment is to shoot hockey pucks the hardest you can with both composite and wood hockey sticks. While the player is shooting there should be someone behind the player with a radar gun measuring how many MPH that the player is shooting and then recording the speeds.

The data shows which hockey stick to use in a hockey game. The better stick based on the data was the composite stick. The composite stick averaged a speed of 42.7 MPH compared to the wood stick which averaged a speed of 36.6 MPH. Based on the data in the chart and from other researchers, a composite hockey is a better stick to use in a hockey game.

In conclusion, if the player wants a harder shot and to score more goals players should use a composite hockey stick in a game.

Let's paint the town

Leslie Tepoxteco Reza

https://docs.google.com/presentation/d/1Ne67v1QjgyVhju_iMKfhl2SmkFXvcaFHZr_03ZtPfZw/edit#slide=id.p

The Effect of Chitosan on the Durability of Keratin Bioplastic

Mina Adabag

Plastic waste is one of the largest threats to all ecosystems on Earth. The utilization of biodegradable materials can mitigate the threat that plastic poses on the environment by reducing its hazardous effects and degradation time . Previous studies have emphasized the brittleness of keratin bioplastics. The aim of this project is to assess the effect of chitosan on the durability of keratin bioplastic films to create a feasible material to replace high-density polyethylene. Chitosan and keratin, both abundant materials, were combined in three different ratios (1:9, 2:3) and assessed using tensile strength, elasticity, and water solubility against a keratin film. It was hypothesized that the ratio of chitosan to keratin 2:3 would result in the most durable film. Using sodium hydroxide (NaOH) for keratin and acetic acid (CH3COOH) for chitosan, the two components were depolymerized to create a bonded hybrid material when combined with each other. The films were dehydrated in an oven and subsequently tested for necessary mechanical qualifications and characteristics. Statistical tests were performed to further analyze the effectiveness of these plastic films in an industrial context . The project gives way to future examinations of the feasibility of mass production of this bioplastic and further insight into the molecular-level process of polymerization of keratin and chitosan.

The effects of 3D printing parameters on build time and compressive strength

Ethan Sandum

The purpose of this research is to determine how 3D printing parameters affect the mechanical properties of 3D printed parts. This research will help to understand how to design the strongest and most efficient 3d printed parts by changing printing parameters. The benefit of this research is that people using 3D printers can know which parameters to change if they want to optimize their part for better compressive strength. My hypothesis is that changing the printing parameters will have an effect on the mechanical properties and the build time of the part. The change in compressive strength will be measured with a compressive strength testing machine. The analysis of the data collected will determine which printing parameters have an effect on compressive strength, and how to change those parameters to increase compressive strength. In addition, this research will determine how changing each variable affects build time. Knowing which printing parameters affect build time is useful because people could use this information to design parts that will take less time to print.

Everlasting Elastics

Kendall White

Disposable latex orthodontic rubber bands remain the national and global standard for treatment of overbite. Despite their natural origin, efforts to compost the bands are generally unsuccessful, given the relatively long time for degradation. The purpose of this experiment is to determine how those elastics break down in various solvents, including oil, water, and salt water. In the future, this research could be used to better understand how latex orthodontic rubber bands and other latex products could be treated in order to be composted in a home setting in a time-effective manner.

The potential application of super elastic Nitinol alloy for use in type III body armor

Nick Carver

Although many advancements have been made in ballistic body armor, there remains a need for improved armor to increase the safety and mobility of the police and military. The super elastic properties of Nitinol due to stress induced martensite support the idea that Nitinol could be an excellent ballistic armor material.This research will contribute to determining the potential application of Nitinol as a type III ballistic body armor material. A Nitinol plate and Nitinol laminate will be tested in multi-shot protection, multiple impacts in a small area, and in a National Institute of Justice type III standard test.

The formation of edible packaging from food waste streams and its applications as alternative packaging to low density polyethylene and oriented polypropylene

Rebekah Thomasson

While useful in food preservation, plastic packaging has long raised environmental concerns, and, as a result, has recently led to interest in edible packaging as a potential alternative. However, current research is limited in terms of the real world applications for biofilms as well as in zero-waste formation procedures. Thus, the objective of this study is to generate zero-waste edible packaging from food waste and test its preservation capabilities compared to commercial plastic packaging materials. To accomplish this, research will identify the optimal material for biofilms and develop and test a zero-waste formation process. The physical and mechanical properties of the generated films, namely thickness, tensile strength, and elongation at break, will then be analyzed and compared to plastic packaging. Shelf-life trials will be performed using the biofilms alongside commercial packaging. Lastly, the morphology of the biofilms will be examined to determine their viability for applications in the food industry.

Feel The Pull

Noah Bandstra

Abstract

Have you ever wondered why the school bell is so loud and goes on for so long? In my science fair project I am testing which metal works best, and can produce the strongest pull in the core of an electromagnet. My hypothesis is that out of nickel, iron, steel, and cobalt, iron will produce the strongest pull. Read more to find out!

The experiment I conducted was measuring to see, out of nickel, iron, stainless steel, and cobalt, which will produce the strongest pull. There were some unexpected problems along the way. For example, the last problem was that we had done the experiment multiple times to get final results, and this magnetized the metals enough to interfere with the equal testing. This happened because the electric current we put through the core straightened the electrons. Luckily, we found out that if we pound on the metal with a hammer, we could confuse the electrons which demagnetizes the metals.

The results of my experiment for the large wire were: cobalt picked up 9 Cm, nickel picked up 5 Cm, stainless steel picked up nothing, and iron picked up 15 Cm. The results for the smaller wire were: 19 Cm for cobalt, 23 Cm for nickel, nothing for stainless steel, 35 Cm for iron. The way we did the test was relatively easy. First we got organized with a twelve volt battery, all our metals, and our different wire wraps. The way we made sure we had equal variables for each one was we took our metal, put it through the coil, and turned on the power. The way we measured the force was we put a bunch of iron filings over a piece of graph paper, and counted how many squares it uncovered or pulled away. I had a lot of fun conducting this easy experiment. Although there were hardships at times, it was very interesting.

Hooked! Fishing Line Experiment

Liam Gottsch

Hooked! Fishing Line Experiment
Liam Gottsch, 5665 Woodcrest Drive, Edina Minnesota 55424
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Susan Kopendrayer

For decades fishing line has been an essential appliance for fishing. This experiment exposes the strongest and weakest commonly used fishing line. This experiment was conducted to test which fishing lines hold up against the elements and which ones are not worth the money. The results of this investigation showed that fishing lines are not nearly as strong as advertised. In fact, this experiment found that some lines can't even hold up to five pounds less than what they are rated for. When companies calculate pound testage they account solely for line strength and they leave the stretch and knot strength out of the equation. This experiment is accurate because it accounts for all variables. The braided line slipped at the knot when testing 15 pounds or higher. The fluorocarbon broke in different sections of the line when testing 15 pounds or higher. The monofilament broke at 20 pounds consistently and once at 15 pounds, hence fishing lines are nowhere near what was expected. When choosing a fishing line there are a lot of things to think about. What type, color, diameter, pound testing, and many more. After conducting thorough tests the conclusion is that the fishing line is not as strong as it claims to be. It can be prone to slip, break or stretch.

Degradation of Microplastics: The Efficacy of Various Bacteria in Breaking Down Microplastics in the Environment

Maya Choi

Microplastics are everywhere in our ecosystem and will only become more abundant. Microplastics severely damage the marine ecosystem as they affect both the top and bottom of the food chain. However, some types of bacteria including Bacillus subtilis and Vibrio anguillarum are able to degrade microplastics. Accordingly, this experiment sought to determine which non-pathogenic bacteria, Bacillus subtilis or Vibrio anguillarum, is able to degrade microplastics faster. To investigate the efficiency of Bacillus subtilis and Vibrio anguillarum's ability to degrade microplastics, both bacteria types were plated onto agar plates and various microplastics were added. The petri dishes were observed under a microscope and photographed twice a day for the next two days. Using a one-way Anova test, a statistically significant p-value was found for polyethylene terephthalate and polypropylene terephthalate, 6.31× 10^-10, nylon flock fibers, 7.24 × 10^-4, and polypropylene fibers, 1.54 × 10^-5. The p-value was not statistically significant for the XAD2 polystyrene beads, 0.329, and the polyester glitter fragments, 0.325. Overall, Vibrio anguillarum degrades microplastics more efficiently than Bacillus subtilis. Vibrio anguillarum could be used in wastewater treatment facilities to prevent microplastics from entering the water and thus save the marine ecosystem.

Killing Bacteria: Green vs. Mean

Ava Drobnick

The purpose of this experiment was to determine if a more natural cleaner, like vinegar, is comparable in effectiveness against E.coli bacteria to a cleaner that uses harsh chemicals, like Lysol. The research conducted resulted in qualitative data that was recorded onto a spreadsheet as well as graphed. Said data was collected by looking at each Petri dish and measuring the length in centimeters from the Lysol, vinegar, or water-soaked disc to where bacteria was growing. During experimentation, the main thing looked at was the zone of inhibition for each independent variable after 4 days of incubation. It was shown that Lysol on average had a 1 centimeter larger zone of inhibition than vinegar, and a 2.5 centimeter larger zone of inhibition than distilled water, the control. Therefore, the use of harsher chemicals is shown to be more effective against E.Coli bacteria than a disinfectant with greener components because fewer bacteria were able to grow with the use of Lysol disinfectant spray. The hypothesis that Lysol would be more effective against Escherichia coli than vinegar was suggested to be true by this experiment. The t-test scores of 14.68487, 22.75274, and 28.77121 were all shown to be statistically significant when tested at the 0.05 significance level therefore the null hypothesis is rejected.

Distinctive mutation profiles of SARS-CoV-2 spike protein in different geographic regions of the United States

Ellen Guo

Mutations on SARS-CoV-2 spike protein have gained increasing attention. However, its mutation pattern in different geographic locations within a country has not been investigated. In this study, over 16,000 sample spike protein sequences from eight states in the US were analyzed by comparing the sample sequences with the reference using the NCBI blastp. The results showed a varying number of mutations and overall mutation rates among different states , with MN leading both. Only two mutations (L5F and D614G) were shared by all these states. The L5F mutation frequency ranged from 0.5% to 1.95% for seven states but reached 7.66% for MN. Most of states had more than a 90% frequency for D614G, except the Western states of CA (82.82%) and WA (66.38%). Some mutations were shared by two to four states, but CA and WA had no additional mutual mutations. Surprisingly, around 50% of the mutations were unique to seven states with A845D exclusive to MA reaching a 7.22% high frequency, while MI had no unique mutation. The E780Q mutation was observed only in WI and MN with a much higher frequency of 9.64% for WI, although structure modeling did not indicate its significant impact on spike protein conformation and stability. Furthermore, E780Q mutants from WI and MN differed with an additional mutation. Hence, the results revealed distinctive SARS-CoV-2 spike protein mutation landscapes in different and even the same US geographic regions, highlighting the urgent needs of nationwide genome surveillance for detecting emerging SARS-CoV-2 variants.

Mouthwash Mashup

Frannys Rojas Garcia

Mario Marinero Chanta

The purpose of this experiment was to determine which mouthwash is most effective in killing bacteria . This is important to know because bacteria can cause harm to humans and many people rely on mouthwash as a part of their oral hygiene. Research showed ingredients such as alcohol are effective in killing bacteria . The hypothesis was that if two different mouthwashes, Plax and ACT brand, are tested on K12 strain E. coli bacteria, then Plax will be most effective because it contains alcohol which has been shown to be very effective in killing bacteria . ACT brand and Plax brand mouthwash were tested on student grade E. coli in Petri dishes. After the bacteria was exposed to each type of mouthwash the zone of inhibition was measured and the data was compared. It was determined that Plax brand mouthwash was most effective in killing the bacteria because it had the largest zone of inhibition.

Salt of the Earth

Vilasinee Makppho

The purpose of this experiment was to determine which concentration of salt water is most effective in killing bacteria . This is important to know because bacteria can cause harm to humans and there are many places on the planet where people may not have commercially made antiseptics available to them, but do have the option of using salt water to fight infection. The hypothesis was that if different concentrations of salt water were tested on K 12 strain E. coli bacteria, then the salt water with the highest concentration of salt would be most effective in killing bacteria . 0%, 1% and 5% concentrations of salt water were tested on bacteria which were cultured on 3M Petrifilm. Sterilized paper discs were dipped into the different concentrations of the salt water and then placed onto the Petrifilm. After 96 hours the zone of inhibition was measured around each disc and the data was compared using t tests. It was determined that the 5% salt water was most effective in killing the bacteria because it had the largest zone of inhibition.

Mouthwash Mixup

Abigael Moseti

Frank Rojas

The purpose of this experiment was to determine which mouthwash is most effective in killing bacteria . This is important to know because bacteria can cause harm to humans and many people rely on mouthwash as a part of their oral hygiene. Research showed ingredients such as CPC are effective in killing bacteria . The hypothesis was that if two different mouthwashes, Crest and Tom's brand, are tested on K12 strain E. coli bacteria, then Crest will be most effective because it contains the most active ingredients to fight bacteria. Tom's brand and Crest brand mouthwash was tested on student grade E. coli in Petri dishes. After the bacteria was exposed to each type of mouthwash the zone of inhibition was measured and the data was compared. It was determined that Crest brand mouthwash was most effective in killing the bacteria because it had the largest zone of inhibition.

The Effects of Disinfectants on Escherichia Coli Bacteria

Audra Johnson

The purpose of this experiment was to determine the best ways to kill Escherichia Coli bacteria. The hypothesis was if chlorine bleach was used instead of hand sanitizer, then more Escherichia Coli bacteria would be killed because chlorine bleach is already used in the medical industry. Chlorine bleach oxidizes molecules in bacteria to kill them. Hand sanitizer dissolves the membranes of the bacteria to kill them. Escherichia Coli bacteria was added to prepared Petri dishes. Paper discs were saturated in one of 2 solutions before added to the Petri dishes at the points of a square. The 2 solutions used were a 5% chlorine bleach solution, and a 5% hand sanitizer solution. There were 4 Petri dishes for each solution, so a total sample size of 16, with a control group of 8. To measure which of the solutions killed more bacteria, the Zone of Inhibition was measured. On average, chlorine bleach provided a larger Zone of Inhibition than hand sanitizer. The results of 3 t-Tests
all showed that the data was significant. The t-Tests were between the control and the hand sanitizer group, between the control and the chlorine bleach group, and between the chlorine bleach and hand sanitizer groups. The hypothesis of this experiment was supported. A source of error in this experiment could be the amount of solution absorbed by the paper discs. If this experiment were to be conducted in the future, more Petri dishes would be used for more accurate results.

The Effect of Homemade Wipes Vs. Clorox WIpes

Kari Chimbo

The question I tried to answer in this experiment was, “are homemade wipes more effective than Clorox wipes?” For the procedure, first make the liquid that is put in the homemade wipes. Then let it sit for about ten minutes. Then wipe two different phones before and after wiping the phone with a sterile Q-tip and dragging it in the petri dish. Then incubate the petri dishes. After the petri dishes have been incubated record your data by counting the number of bacterial colonies. I found that Clorox wipes were more effective than homemade wipes, but that homemade wipes are also very effective. Clorox wipes started with 239 bacterial colonies and then had three bacterial colonies in the first petri dish and two bacterial colonies in the second petri dish after it was wiped, and homemade wipes started with 279 bacterial colonies and had two bacterial colonies in the first petri dish and six bacterial colonies in the second petri dish. In conclusion, Clorox wipes were more effective, but homemade wipes were also very effective. This means that people can make homemade wipes at home if they are not able to go to the store and get Clorox wipes or if the store just ran out because of the pandemic that all of us are going through.

Investigation of the Antimicrobial Properties of Natural Ingredients

Prisha Rathore

In this project, I go over some major issues such as the overuse of antibiotics and the challenges of making new antibiotics. By using the Agar Plate Method, I investigated the antimicrobial properties such as ginger, turmeric, garlic oil, clove oil, and honey, and I concluded that clove oil shows superior antimicrobial activity. I also did a concentration study on the antimicrobial activity of clove oil/canola oil.

Assessing the anti-quorum sensing activity of essential oils on Escherichia coli K-12 samples

Ella Albrecht

Quorum sensing (QS), a form of bacterial cell communication, involves the exchange of microscopic signaling molecules called AHLs, which play major roles in bacterial gene expression. Quorum sensing allows bacteria to form a biofilm, which is a dense colony of bacterial cells that are often pathogenic in nature due to their QS-regulated adaptation methods. This renders numerous drugs virtually useless due to this antibiotic resistance, something that poses a huge threat in the global medical community. Taking into account this immediate need for solutions to the growing problem of bacterial resistance , this research aims to utilize the antibacterial qualities of essential oils (EOs) in order to determine their anti-QS activity, and consequently, their ability to fight antibiotic resistance. A main goal of this research is to gain a better understanding of QS mechanisms and the genetic expression aspect of bacterial resistance. The experimental design will be composed of an in vitro disk diffusion assay in which the E.coli strain K-12 will be exposed to four different EOs: clove oil, eucalyptus oil, peppermint oil, and oregano oil, and their four different components: eugenol oil, eucalyptol oil, menthol oil, and carvacrol oil. It is hypothesized that the EOs will inhibit E.coli K-12 growth, but some EOs will have a greater inhibitory effect than others.

Analyzing the effects of Lactobacillus Rhamnosus as an alternative to antidepressants on Caenorhabditis elegans model organisms by determining its impact on locomotion, lifespan and pharyngeal pumping rates

Ava Chen

The purpose of this study is to analyze the potential of Lactobacillus Rhamnosus, a probiotic, as an alternative to antidepressants on Caenorhabditis elegans (C. elegans). Probiotics are shown to reduce the risk of gut dysbiosis, a disease that is related to major depressive disorder. Current research has shown the positive effects of probiotics without determining which neurotransmitters, such as serotonin and octopamine, are responsible for its effects (Bermúdez-Humarán et al., 2019). Based on past research, the hypothesis is that exposure to Lactobacillus Rhamnosus will increase the levels of serotonin and octopamine, mimicking the effects of traditional antidepressants. This will be indicated by changes of locomotion, lifespan and pharyngeal pumping rates. QPCR will be used to compare the gene expressions. The results of this study will determine which specific serotonin receptors are required for a lifespan extension by Lactobacillus Rhamnosus and contribute to the finding of an effective probiotic treatment for major depressive disorder.

Degradation of PET-based plastic pollution using Ideonella sakaiensis

Berit Cummings

This study focuses on the degradation ability of PET-based plastics by the bacteria Ideonella sakaiensis and its potential applications to marine plastic pollution. Plastic pollution in the oceans has been increasing rapidly and the consequences of this pollution for marine life and ecosystems continues to amount. Although I. sakaiensis is a soil-dwelling bacteria, previous research has indicated it is able to survive in seawater through genetic modification. This study expands on factors outside of genetic modification that are necessary to consider before using I. sakaiensis to control oceanic plastic pollution. Specifically, this study addresses plastic degradation by I. sakaiensis using pollution samples taken from river environments under the assumption that such pollution will eventually reach the ocean. Previous research primarily concerns pure PET degradation, making expansion to real-world pollution necessary to explore. The hypothesis is that while degradation may be slower than in control samples with pure PET plastic, degradation of existing pollution will still occur.

Effects of methoxsalen and UV radiation on subcutaneous P. destructans infections through the use of S. cerevisiae and G. mellonella as models

Alison Crandell

White Nose Syndrome is a fatal disease where the P. destructans fungus grows on the face and wings of bats. The disease has spread to 33 states, and over 6 million bats have died since its initial reporting in 2007 in Albany, New York. Previous studies have shown that UV radiation is capable of reducing growth of P. destructans colonies in a lab environment, and that the psoralen methoxsalen increases the effectiveness of these UV exposures. The purpose of this study is to determine whether UV treatments coupled with the psoralen methoxsalen are effective in treating subcutaneous and dermal P. destrcutans infections. A UV susceptible strain of S. cerevisiae will be used as an alternative to P. destructans, as it's a well studied and safe psychrophilic fungus. The larvae of G. mellonella will be used as a lab alternative to bats, as their immune systems share similarities. All larvae will be injected with the yeast, and some will be injected with the psoralens while others will receive a control. Larvae will then be exposed to UV radiation. Data will be collected weekly in the form of colony forming unit counts.

Crayfish DNA decay rates in sediment and water

Emily Stoebe

This study is being conducted to determine the differences in eDNA decay rates and concentrations in F . virilis. F. virilis is one of many invasive species of crayfish. To locate and track their numbers, scientists have developed a new method of using eDNA (environmental DNA) to detect invasive species. Basically, scientists will collect field samples of either water or sediment and test for DNA that matches the target species. If DNA of that manner is found, it is concluded that the target species is present in the environment. This study aims to aid with that. According to previous studies, sediment retains eDNA longer than water. However, no studies have been performed comparing different types of common sediment (sand, mud). Based on this information, we believe that mud should be the best sediment for retaining eDNA followed by sand and then water. This data will be gathered using harvested DNA that has been inserted into sediment and water samples. DNA will be extracted using EZNA DNA extraction kits, selected using gel electrophoresis, and quantified using qPCR. This process will be repeated once every 2 weeks for 4-5 months. Data will be recorded in Benchling each time qPCR is performed. At the end of the study, the data will be combined into a line graph and projective equations will be generated for each line. This will allow for easy comparison of the different mediums. The results will be analyzed and will aid researchers in deciding which medium to test for eDNA presence.

Small But Mighty: The Power of Silver Nanoparticles

Isabelle Murillo

Products containing silver have been marketed as beneficial health supplements for a while. The issue is figuring out if these products really work and if the products are worth it. I decided to test the antibacterial effect of a colloidal silver product using agar plates to watch the growth of bacteria with different dilutions of the colloidal silver. I predicted that less of a dilution would result in less growth. The results I got were exactly as predicted. I measured the line of inhibition in millimeters, which acts as a way to determine how well the dilutions prevented bacteria growth. The largest dilution, which contained 50 micrograms per liter, had an average line of inhibition of 0 while the largest dilution, containing 500000 micrograms per liter, had an average line of inhibition of 4.25 millimeters. My findings contributed data to the medical world. Colloidal silver, in this instance, is very effective in preventing bacteria growth.

The Most Eggcellent Science Project

Mason Deegan

The purpose of my experiment was to see how much salt I would need to add to normal tap water to make an egg float in said water. I was interested in this topic because I wanted to do something related to liquid, like maybe something to do with viscosity, or salinity. Then all of a sudden I had an idea for a simple test that would be fun to do, and research. I would test how the salinity of water would affect how well an egg would float. The way I did my experiment was quite simple, I took one large measuring cup, and filled it with ½ a liter of water. Next I took an egg and gently dropped in the water so it wouldn't break, I did three tests of this. Then I added one teaspoon of salt then dropped the egg in. I repeated this adding one teaspoon of salt every three tests until I got to twenty teaspoons of salt. It took awhile so I only added the averages to the graph that I thought best represented the experiment. My data was overall all pretty expected, as my hypothesis said, When I add more salt to the water, the egg will float better. When there were only five teaspoons, or 28 grams of salt the egg did not float, but when there was 20 teaspoons, or 112 grams of salt the egg floated the highest at an average of 5.66cm. in conclusion the more slat I added to the water the egg floated higher.

Optical Tweezers

Justin Draheim

Todd France

The Optical Tweezers Apparatus won the Nobel Prize back in 2018 for its groundbreaking applications of laser physics in various fields of study. This invention can move microscopic objects with a laser beam, much like a real tweezer would. We wanted to create a budget version of this invention for future use in our school. To do this, an optical apparatus was built where an LED laser beam was produced that travels through various lenses and through a tightly focused microscope objective to create an optical trap with which we can trap these microscopic objects. Once the object is in the trap, we can move the translation stage of the microscope and the object moves to be in the center of the beam. To keep cost down, we repurposed one of the microscopes our school already owns. This required some redesigning of the apparatus, but it kept the project within budget while still providing functionality. So far, we have been able to trap microscopic beads with the laser beam, but we plan to trap more microscopic objects in the future, such as cells and DNA molecules. We hope that the Optical Tweezers can be a great tool for future projects at our school and that it makes a positive impact on our school's community.

The Result of Common Building Materials on the Strength of a Radio Signal

Jacob Johnson

The purpose of this experiment was to determine how various building materials affect radio wave propagation and strength . The experiment had three materials: drywall box, bricks, and an aluminum foil lined bag, each designed to replicate a real world environment. Transmissions were made from both inside and outside the materials to determine how radio waves travel in each direction. Each material was tested thirty times, and data was gathered using a software driven radio program (SDR#). Reflected power was also measured using an SWR meter, to ensure that damage would not be caused to the radio equipment. Testing showed that transmissions from inside the material had no significant impact on signal strength , except for approximately one third of aluminum foil tests - which showed decreased signal strength. While receiving from inside the materials, the drywall box affected signal strength minimally positive , while bricks and aluminum foil decreased signal strength. The experiment supported other findings that various outside forces can greatly impact Ultra High Frequency signals, and that metal materials significantly affect radio signals . It also supported other findings, when transmitting from inside the material, that showed materials with particle sizes smaller than the wavelength of the radio signal do not have a significant impact on the signal strength. The data showed variance in signal strength, but supported the hypothesis that high reflectivity materials attenuate signals more than other materials tested. Future studies could be conducted to account for outliers in the data gathered in this experiment.

Detection and Characterization of Astronomical Dwarfs using CatWISE

Tarun Kota

In an effort to complete the census of Astronomical objects in the solar neighborhood , we have been searching for dwarfs such as brown dwarfs, low mass dwarfs stars, white dwarfs, etc. Due to their low luminosity, dwarfs(especially cold dwarfs) often make up the majority of missing objects in a census of a certain region. However, CatWISE has improved upon the motion and infrared measurements of AllWISE by leveraging archival WISE and NEOWISE data collected from 2010 to 2018 at W1 and W2 (Eisenhardt et al. 2020). The improved astrometric accuracy will lead to the discovery of previously unrecognized high motion dwarfs in the solar neighborhood. We used a test dataset of high-proper motion objects from CatWISE made by candidate selection criteria outlined in Meisner et al. 2020. We then implemented a self-created data reduction pipeline that first pairs these objects with their 2MASS counterparts through a cone search. We then made color-color diagrams of the motion candidates and then manually searched for interesting outliers. From the initial testing of the pipeline on the test dataset, we present the discovery of a low mass star, a subdwarf, 4 white dwarfs, and one object of "an unknown type". We also present additional follow up on two other objects published elsewhere . In the future, we plan to incorporate more sensitive databases like UHS and VHS which will increase the efficiency of our pipeline . Furthermore, this will allow us to go deeper with the color-color diagrams and uncover a trove of interesting objects.

Correlation between type of glove and catch performance

Cade Bunnell

The purpose of this experiment was to determine which type of football glove had the highest percentage of catches when thrown at from two different distances. The hypothesis was that if using receiver gloves to catch footballs from different distances increases chance of catch, then using receiver gloves will result in a higher percentage of catch due to the traction provided. Information on types of gloves and similar experiments done to this topic was researched and studied. Three participants were used from two different distances with three variables. Directly across from the participant was a jugs machine that was a certain distance away. One distance being 10 yards, the other being 50. The footballs were loaded into the jugs machine and launched at the participant. To eliminate sources of an error a jugs machine was used and the data was collected inside of a dome . The data was recorded for all three participants using each variable at two different distances. It showed that the type of glove has an effect on the percentage of catch, but the data was not statistically significant. It was assumed based on the research collected that the receiver glove and padded gloves performed better than the bare hands variable because of the traction and friction provided by the glove on the football. In conclusion although the receiver gloves did result in the highest overall percentage of catch, the difference between that and the others was not statistically significant at the 0.05 level of significance.

The Strobe Effect of a Monitor

Elroi Beyene

I am doing my experiment because I am interested in modern technology. The monitor is one of the many things I am interested in. I wanted to choose a topic I knew I would do a good job on and was interested in. Also I thought that this experiment would be one that everyone would enjoy and so would I. So I am doing this project to see if my hypothesis will be supported when I am done with this.
First I will set up my monitors, the cables and put the snacks in place. Then stand in place looking at the monitor. Afterwards take the crunchy snack, chew on it and make sure to swallow it. After that start marching in place and avoid moving your head too much. Then start shaking your head side to side for a little bit.
In my data I found that the answer to my question was yes, by your motion and chewing the “crunchy” snack this experiment was a success. So my hypothesis was mainly correct. I thought that this could solve anxiety and stress but I was wrong and two I thought this would have one potential risk which wasn't a risk but I thought choking was going to be a problem but when I tried my experiment the directions said to chew.

Temperature Magnets and Perpetual Motion Machines

William Mattson

My purpose of doing this experiment is to learn more about physics. I am also doing this experiment because perpetual motion is very interesting. This is very interesting because it does not work but why attempt this. Well people in the past did this to learn. This is also like me to learn about physics. But also to unlimited energy which could be good in some ways.
My procedure is simple. I have to start with a base then putting a metal pole in the middle of the base. Then with a barring I glue it onto the clear lid and put it on the metal with nuts holding it in. Then glue magles and a stick with two magnets on the stick then the nut goes in. Then I got all of my data.
My data was very surprising. I thought that a cooler magnet would make it longer. But on my data it was barely right. This is because it was eight milliseconds faster. So in my results I really did not get it the best.
In conclusion I would say I was in the middle. This is because I only got it right by just barley. But I was kind of wrong too because it was really the same. But now I see how hard it is to do. Which is also why it was never achieved. Lastly I could make this more accurate by having a hand that would push at the same speed.

Hydro Flask Versus Yeti - Which One Stays Hotter or Colder?

John (Jack) Larson

Hydro Flask Versus Yeti - Which One Stays Hotter or Colder?
John (Jack) Larson
Transfiguration Catholic School, Oakdale, MN, USA

There are a lot of options available when looking to buy a water bottle. Two of the most popular brands today are Hydro Flask and Yeti. The purpose of this experiment is to find out which water bottle keeps the temperature of ice, hot water, and cold water the longest to find out which water bottle to buy.

The materials used in this experiment are Yeti 16 ounces, Hydro Flask 32 ounces, Hydro Flask 20 ounces, ice cubes, cold water, hot water, timer, and temperature sensor.

To do this experiment, put ice or water in the bottles, measure the temperature of each bottle every 10-30 minutes, then repeat.

By looking at the data collected during all three tests, the Hydro Flask 20 ounce bottle is the best.

The reason this experiment is important is that consumers do not want to waste their money on a bad water bottle. Consumers want to spend their money on a good water bottle. Consumers want a water bottle that will keep cold drinks cold and hot drinks hot for a long time.

The impact of drafting in cross country skiing

Austin Hunter

The purpose of this study was to determine the optimal drafting formations for reducing the aerodynamic drag experienced by a group of cross country skiers. Previous studies on cycling and running have quantified the impact of drafting in their respective sports, with as high as a 96 % reduction in cycling and a 57% reduction in running (Blocken et al. 2018; Polidori et al., 2020). While cross country skiing occurs at speeds between that of cycling and running, there is also greater distance between athletes. To analyze the influence of these different factors, this study developed a 3D model of a cross country skier, conducting a Computational Fluid Dynamics investigation using Solidworks Flow Simulation software. Seven different formations from different endurance sports were compared at a speed of 8 m/s. The results indicated a drag reduction of as low as 69% compared to the forces experienced by an isolated skier, and an average reduction of 57% for the entire group of skiers. The study determined linear patterns were most effective in reducing the mean drag experienced by a group of skiers , though further research is needed to corroborate the results of the CFD simulations with wind tunnel and real world data.

Analyzing the Impact of Snowboarding on an Intermediate Rider

Ian Stine

The purpose of this study is to analyze the impact snowboarding has on the human body. For many years researchers have studied the sport, and out of that has come new protective gear, equipment, designs, and ideas that help further progress snowboarding as a sport. How this is important doesn't just apply to snowboarding itself, but the results of any research in the sport may lead to innovations in other similar sports as well. Injury prevention research comes in direct correlation with analyzing what different forces act upon which parts of the body, and with this in mind, snowsports will become safer over time. Most of the research out there is collected from trained professional athletes that are at the top of the game, knowing this I want to find out how snowboarding affects an intermediate rider. My objective is to find out what the difference may be if any in the force data collected from my studies. I plan on collecting data through means of using force sensors from head to toe, which will show how forces are distributed across the body, as well as video capture to show what I'm finding. As well as those two tools, I will be using either my phone, or apple watch to track how much energy I burn. All of the data collected will be put into graphs and charts, and then compared to similar data collected on professional athletes to hopefully answer my question.

Investigating the Relationship Between Young's Modulus and Temperature Using Inline Digital Holography

Zhaomeng Chen

Young’s Modulus, also known as the Modulus of Elasticity, is a constant that is affected by temperature and is used to predict when a deformation will occur in a material. Thus, this constant is crucial to many professional fields when considering the safety and functionality of designs and materials. The purpose of this study is to investigate and determine a mathematical model for the relationship between Young’s Modulus and Temperature. This will be done by creating and using a device that utilizes Digital Holography to collect quantitative data in transparent materials in order to determine its Young’s Modulus at different temperatures. The optical set-up will be designed for Inline Digital Holography. Multiple experiments will be conducted using test objects to ensure accuracy and to calibrate the setup, An experiment to determine the Young’s Modulus of chosen transparent materials at different temperatures will be conducted and the information collected will be used to determine a mathematical model.

The Effects of Storage Temperature and Exogenous Ethylene Exposure on the Ripening Rate , Quality, and Glucose Level of Postharvest Ripened Tomatoes (Solanum lycopersicum)

Eleanor Chen

The purpose of this study was to determine if higher storage temperatures and exogenous ethylene exposure would increase the ripening rate and maintain the quality (less decay and mass loss) and glucose level of postharvest ripened tomatoes. In total, 12 experimental groups, each starting with 20 mature green tomatoes (250g), were stored in cardboard boxes under different combinations of ambient or refrigeration temperatures (4oC, 15oC, 22oC) and amounts of exogenous ethylene produced by bananas (zero, one, two, three). Mass and hue angle, a common standard used to determine the ripening stage of tomatoes, were collected daily throughout the experiment. Glucose levels of tomatoes were collected once tomatoes were ripened with a hue around 40. Tomatoes at 22oC and 15oC ripened significantly faster compared to 4oC (t-test, $p<0.0001$). Tomatoes at 15oC displayed the lowest amount of decay. Storage temperature was not found to affect tomato glucose level. The results of this study partially supported the hypothesis and were likely due to tomato ethylene and lycopene synthesis being sensitive to temperature conditions during its ripening process. The study's limitations on banana ethylene inconsistency prevented connections between exogenous ethylene and tomato ripening, quality, and glucose level to be made.

The effect of UVC exposure on germination rate, time until germination and growth rate in radishes (Raphanus sativus)

George Montague

The purpose of this study was to research whether an increased UVC radiation exposure on seeds (Radish, Raphanus sativus) had a detrimental effect on the germination rate, growth rate, and time until germination. There were two experimental groups, and one control group. Seeds of both experimental groups were exposed to 254nm UVC rays, one for 5 minutes (7.5kJ/m²) and one for 10 minutes (15kJ/m²). The control group received no radiation. The plant's heights and germination statuses were recorded every 3 days over a 5-week period. Compared to the control, the 15kJ/m² group had the greatest significant growth with an average of 22mm/day of growth, 3.13 days until germination, and a germination rate of 64% (t-test with 0kJ/m² ($p<0.05$), t-test with 7.5kJ/m² ($p<0.05$)). The 7.5kJ/m² group had a non-significant change with 24mm/day of growth, 3.04 days until germination, and a germination rate of 48% (single ANOVA $p>0.05$). The hypothesis was not supported as an increase of UVC radiation exposure resulted in higher germination and growth rates, and fewer average days until germination. This is presumably because the higher-energy UVC rays damaged the seed coating, lipids and proteins, thus facilitating growth.

All photographs & graphs are by student unless otherwise marked

Optimizing photoperiod to improve drought resistance in Arabidopsis thaliana

Isabel Toghramadjian

This study sought to explore the effect of environmental light conditions and drought stress on the mass and number of leaves of Arabidopsis thaliana. A. thaliana was grown under 14hr/10hr and 12hr/12hr light/dark conditions. 25 days after germination, half of the plants in each condition stopped receiving water, while the other half was watered as usual. 42 days post-germination, the plants were harvested, leaves were counted, and dry aerial tissue mass was measured. A 2-way ANOVA indicated that the interaction between the photoperiod and drought variables had a significant impact on the number of leaves ($p<0.05$), but not on the mass of the plants. However, more trials involving additional photoperiods and more nuanced drought conditions need to be performed in order to fully understand the interaction between the drought stress and light variables. Applications of future research could be relevant to increase agricultural efficiency as climate change limits the available resources.
Keywords: Arabidopsis thaliana, drought stress, photoperiod, circadian clock, leaf number

Survival of the Plants

Eliazbeth Genis

The purpose of this research was to see how different water sources with the same pH of 8.8 can affect the growth, taste, color, and strength of the potted plants. House plants can live off of an Alkaline pH (above 8 or 9) but this experiment was testing how a greater pH base would make the plants react. The hypothesis that was being tested was, If the house plant is given the ‘Leveluk SD501 Kangen Water Machine’ then, the plant would grow and have a more healthy life than the potted plants that got ‘Exhilar 8 Alkaline Water’ from Hy-Vee. The collected data showed water from the ‘Leveluk SD501 Kangen Water Machine’ gave the 12 potted plants life for 10 days and gave them strength, tasted correct, and had a healthy look. Group B that got ‘Exhilar 8 Alkaline Water’ from Hy-Vee started to get brown leaves and a weak stem. They tasted bitter and were weak by the 6th to 7th day of research. In conclusion, this experiment showed that it was important to use a water source that best fits the plants needs. A water source that is clean and has an 8.8 pH base. It is very important for the houseplants that are owned by any individual.

Does Salt Effect Cat Grass Growth?

Harper Burns

First, I planted the cat grass seeds in the pots with the potting soil in them, Then I watered all of the pots with just plain water so then I got a higher success rate of cat grass growing, After I got 1 cm sprouts I started watering the plants with the saltwater, I watered all of the pots with saltwater except for three which were my controls. After I finished my experiment the results were that the control grew the best so my hypothesis was wrong

Which Color of Light Makes Plants Grow the Tallest

Jack Kirchberg

The purpose of this experiment was to find out which light color makes plants grow bigger and faster. Some colors have different effects on plants, red light helps with photosynthesis and purple light gives it more energy.

The experiment will be conducted by growing two sets of plants each with five colors and three plants for each color. The lights will be on for twelve hours and off for twelve hours. The plants will be given 20mL of water every day over a twenty-five-day period. The height will be measured every day and recorded.

Green light promoted the tallest plant in both sets with blue coming second in the first trial, but purple was second in the third trial. Red was third in both trials in the second trial in the last seven days the plants grew0.5cm. Clear was the shortest in the first trial and did not grow in the second trial.

The real-life applications of this experiment could be applied in commercial green houses or other plant growing facilities. Unlike other ways to make plants grown faster or bigger, light is a very inexpensive and easy way of accomplishing it. Especially when growing massive amounts of produce, changing light color will not be hard.

Which Liquid Helps Radish Seeds Grow Best?

Conor McCarthy

The purpose of this experiment was to see what liquid helps radish seeds grow best.

Green tea, vitamin water, filtered water, and club soda were used. Data was collected by taking pictures and writing observations in a notebook. This project took place over a three-week period. The seeds were watered with 1/4 of a cup almost every day for the three weeks. The plants were put in the sun for six hours a day to receive sun light.

The results of this experiment were green tea did the best, second was the club soda, third was filtered water, and lastly was the vitamin water.

This can be helpful for plant growers looking for a good way to grow plants. What prompted this project was people grow plants usually with water but, this experiment gives other options to grow plants.

The Great Wall of Plants: The Effect of Plants on Soil Erosion

Cassidy Gaston

The question I was trying to answer in my experiment was; “ What kind of plant most effectively stops soil erosion?” I wanted to do this project because I am passionate about plants and I find them very fascinating. When I performed this experiment I planted radishes and grass in two different bread pans. When they reached about 15-20 centimeters in height I made two 1 inch cuts down the front of the pan and folded down the small rectangle. I then propped the pan with radishes up a few centimeters high and I poured water from a watering can on the plans for five seconds. After that I separated the water from the soil, I measured the mass, and I recorded my data. Next I repeated this process for the pan with grass and the pan with only potting soil. After I finished my project and recorded my data I found that grass most effectively stopped soil erosion with only 10.07 grams of soil that fell out of the pan. The radishes did the second best job with a total of 32.27 grams of soil that fell out of the pan and the control group had 43.62 grams of soil that fell out of the pan. In conclusion, the grass most effectively stopped soil erosion and the control group was the least effective at stopping soil erosion .

Do LED Lights Affect a Plant?

William Molina Alvarado

The purpose of this experiment is going to be about plants and I am going to show you guys some things about my plant. So the plant that I bought couple weeks ago there was some cool things about the plant and everything is going great and the plant didn't die and its still alive and then the first day that I bought the plant and I got the seed and then I waited for couple of weeks and then I did some research and then I found out that it takes three weeks for the plant to grow and then I waited then the plant started to grow big and starting on a medium sized plant and there was some cool things that the plant was it was growing and then I did some research about the plant that I bought and then it was going to be a big plant and I said to myself that it going to be cool and there was some cool thighs and might be some new things to this plat and I noticed that this plant can grow really big and then I needed to go buy some good soil and then it was going to be growing and I wanted do this experiment because it was kind of a thing that I already know and somethings
Compared to it. I did some things with this plant because it took a while to grow this plant and now it's alive. When the plant started to live and there was some new things that were going to grow an different kind of plant because it takes grows long and it takes some time to grow because the plant
That I bought takes like one week to grow naturally.

pH and Plants!

Elizabeth Foley

My purpose for this experiment is to find what pH would make beans grow the tallest. I wanted to know if a high pH, a basic pH, or a low pH would make bean seeds grow the tallest. I first tested the pH of 3 bottled waters. On had a low pH, a basic/middle pH, and a high pH. After receiving the pHs I planted 30 bean seeds and watered them two times a week. Each time I watered them, I gave each plant 16 milliliters of water. Every week, I calculated how many sprouts each type of water had. I grew my plants for three weeks. At the end of the three weeks, I took the averages of each of the three groups and found which pH made the beans grow the tallest. The low pH had an average of 137 centimeters. The basic/middle pH had an average of 118 centimeters. The high pH had an average of 92.8 centimeters. With this data, I found that the low pH made the bean plants grow the tallest. In conclusion, the low pH had the best growth and the high pH had the worst growth out of all of my plants.

Sudsy Basils

Kayleigh Skjod

What prompted this experiment is that when people are planting, the plants may just die and with this experiment it can be figured out if people can add soap to plants it may help the plants. When the project is done people can know the answers whether soapy water is good for a plant or if it is bad for the plant, it can help anyone who farms or plants food or any plant for a living. Because if people know if soap is good or not it can help them if someone plant is dying or any person that plants for a living or just likes planting.

The experiment was conducted by putting little amount of soap in six out of nine plants. Another thing that was done is that the plants were watered every other day and this experiment lasted for ten days, so they got watered 5 times. And after 4 days, it was observed that the leaves on the plants with soap were starting to shrink and die. At the end of 10 days the plants without soap were healthy and the plants with soap were not healthy, they had decreased in size and the leaves were almost dead.

The results for this project are that soap does affect the plants but not in a good way . The way it affected the plant was that the ingredients killed the way coating on the outer part of the leaf. After the leaves were dying because of the soap the plants started to not look the best. They started to lose their green color and after 5 days they started to shrink.

The applications for this that could be used in the real world are, farmers it will be good for farmers to know that soap is not good for the plants. It could also help scientists who work with plants. Because if they want the plant to be healthy, they should know that soap in plants is not good for them.

The Effects of Music on Plants

Marco De Leon

This project is a result of experimenting the effects of music on plants. The purpose was find out how music affects the growth rate of plants. Different amounts of sound affected plants differently.
The plants were put into different groups. The plants were watered. One of the groups listened to music. After, the plants were measured. The plants grew for about three weeks. The Music group's rate was 94 mm. The Normal group's rate was 82 mm. The No Sound group's rate was 67 mm. The Music group had the highest rate, and the No Sound group was in the middle, and the Normal group was the lowest rate.
I experimented with the effects of music on plants. Music increased the growth rate of plants. Music was the highest, No Sound was the middle, and Normal was the lowest. There were many difficulties and changes I would make if I were to do this experiment again.

Does Saliva Affect the Growth Rate of A Bean Seed?

Victor Estrada

The purpose of this experiment is to see which method of germination of a bean seed would make the seed grow better. My hypothesis is that the bean seed that germinated in the mouth will grow faster than a bean seed that germinated in a wet paper towel.
The length of the bean seed roots were measured in millimeters. In my results it appeared that the beans that sprouted on the mouth grew longer than the seeds in the wet paper towel.
At the end of the experiment my hypothesis was correct because the beans that germinated in the mouth grew 1 to 2 millimeters longer than the wet paper towel ones.

The effect of water tempature on plant growth

Izzy Carlson

The experiment went really well. First planting the seeds was a little tricky but it was also good. And getting the water ready to the right temp took a while too. But the measuring and recording went really well. All together the experiment went ok. Why it went ok was beacause this experament went ocording to plan

The Elucidation of a Novel Laccase-Producing Fungal Strain with an Alkaline pH

Isabella Escalante

Applied natural selection: the effect of sethoxydim on lipid production in algae

Maya Silver

You Are My Soil-Mate: The Effects of Fertilizer Composition on Radish Plant Growth

Ayres Warren

Christina Radichel

As environmental consciousness is increasing and people turn to more sustainable solutions, urban gardening has become increasingly popular. In these gardens people are using different fertilizers to support their plants growth , and while fertilizers may be good for the plants, they can disrupt many ecosystems. When excess elements from fertilizers, like phosphorus, are released into the environment they can enter the water system and create algae blooms and dead zones, which seriously harm the organisms that live around them. Previous research found that smaller soil areas from the gardens still carried large amounts of phosphorus and there was a positive relationship between soil age and phosphorus levels. We wanted to further test the extent of various fertilizer treatments on their benefits to plant growth and their effects on phosphorus leachate.We used 5 fertilizer treatments to test these conclusions: a control, a nitrogen only (N), a phosphorus only (P), a nitrogen potassium (NK), and a nitrogen phosphorus (NP) treatment. We concluded that a nitrogen based fertilizer works best for growth. Our data showed high levels of phosphate in leachate from all groups, but no significant difference between phosphate levels in leachate outputs between the groups . Through our research we can make urban gardening more beneficial and sustainable for cities and their surrounding areas.

If You Plant It, They Will Come: Planting for Pollinator Diversity in Your Home Garden

Hannah Grosser

Gardeners wonder what flowers to plant in order to attract the most pollinators. This experiment was performed to determine whether native perennial gardens attract a higher pollinator diversity than annual gardens. Because pollinators move from flower to flower, and there are many of them, it would be impossible to tell the number of pollinators attracted to a garden. The independent variable was the garden, and the dependent variable was the number of types of pollinators attracted. The hypothesis for this experiment was that the native perennial garden would have the highest pollinator diversity. To understand the impact of garden type on pollinator diversity, a perennial garden was planted and established. Then an annual garden was planted and established. For fifteen minutes in each garden, twice a week, the pollinator species attracted were observed and photographed. The temperature, weather, and exact time and date were recorded. Most days, the native perennial garden attracted a higher diversity than the annual garden. The average number of types of pollinators attracted to the perennial garden each day was 11.8 pollinator types, and the average number of types of pollinators attracted to the annual garden each day was 7.67. Though the exact number could not be recorded, it was observed that the pollinator garden also attracted higher pollinator numbers. This data confirms the hypothesis; that perennial gardens attract higher pollinator diversities than annual gardens. Regardless of whether gardeners plant perennial or annual, attracting pollinators is important to help the environment and grow gardens.

If the Use of Drones in Search and Rescue (SAR) Operations Affects the Efficiency of the Mission and the Likelihood of a Rescue

Michael Nobrega

I am testing if the use of drones in a search and rescue operation affects the efficiency of the mission and the likelihood of a rescue. This experiment is important because searching for a missing person on foot isn't always an option and putting technology to use helping other people rather than just to help ourselves is incredibly important. I conducted my experiment by first having a ball hidden somewhere by someone other than myself and I would then use my drone to help me search for the object. If I found it, I would record how long it took me, the weather, environment, and a few other important factors such as elevation and takeoff point. Based on my experiment results with use of a recreational drone, I discovered that there wasn't a massive change in the amount of time that it took me to find a missing item with a drone vs. by searching on foot. I think this happened because I was using only a recreational drone which is not as powerful as the drones that police officers and firefighters use, which often have thermal cameras and powerful spotlights, meaning that factors like bad weather or visibility often decided if I found the missing item or not. However, it's important to note that a more powerful drone would most likely be able to defy these factors and find the missing item, thanks to better and more advanced technology.

Using Machine Learning to detect Phishing Scams

Isaac Berlin

Developing a video game AI opponent capable of maintaining a skill level proportional to that of the player

Nathan Turcotte

Training Machine Learning Models to Determine Archery Scores

Julian Byrne

In target archery, rounds are usually scored manually. When archers are practicing on their own time, it would be efficient to have an automated system that can identify and record the archer's score. Additionally, the ongoing COVID-19 pandemic has made clear the benefits of having methods for completing certain tasks with minimal human intervention. Therefore, it would be useful to have a system to automatically determine the score of arrows, which would have the benefits of increased efficiency and reduced human input required.

This project aims to develop a machine learning model that, when trained on images of arrows and targets, can identify the scores of one or more of the same type of arrows in the same type of target. Additionally, it aims to determine the conditions for photos, including angle and background, that would be most accurately scored by such a model. Major difficulties to this project will likely include the angles of the arrows or the difficulty of scoring arrows that are partially or fully overlapping in the image. Therefore, the developed model will likely be able to reliably score one arrow, but not several. Additionally, it will have to be trained separately to score arrows or targets with different qualities, such as differently-colored shafts. If the project is successful, it will be able to reliably score one or several arrows in a target in a reasonable timeframe.

Teaching Manufacturing Robots with Kinesthetic Learning from Demonstration in a Miniature Replication of the Work Environment

Eli Hooker Reese

Manufacturing work is evolving: the ability for robots to complete work creates more demand for programming/operation of the robots, in turn shifting the purpose of human factory workers toward these jobs. However, factory workers are not trained or skilled in programming, creating the need for some simpler method to program manufacturing robots. This simple method comes in the form of Learning from Demonstration (LfD), a way for humans to demonstrate potentially complex tasks to a robot in order to program it. Significant recent research has been done concerning methods and uses of LfD, and although it is becoming more usable in real-life settings, there are still some roadblocks. In this study, a method of kinesthetic learning will be designed using a miniature replication of the robot and work environment. Specifics of this method will be determined, the programming skills to create this method will be learned, and the uses of this method will be explored. Additionally, attempts will be made to use AI to enhance this method, and to test the method using simulation software or a factory-scale robot.

Robotic Arm Plants for Climate Change

Kevin Armstrong ||

Right now, the world is grappling with the challenges of climate change because we have too large an amount of greenhouse gases. CO2 is the most major greenhouse gas and trees are able to suck in CO2 as part of photosynthesis. So if one can plant more trees, one can potentially mitigate climate change if done on a major scale. I have designed, made, and programmed (with Arduino) a robotic arm that can place seeds, encased in ice, on the ground. The frozen water, ice, melts and in the process softens the soil on the ground which allows the seed to sink into the ground. Because the arm can plant seeds autonomously, it can plant more trees in a faster time than would be humanly possible.

Innovative Chatbot Solutions: Designing a conversational agent to promote student success during distance learning

Ananyaa Arvind

COVID-19 has dramatically changed the high school experience. Students have faced a variety of setbacks and challenges, from the cancellation of extracurricular activities to grieving the loss of loved ones. These challenges, among many others, led to a significant loss of motivation for many students, who found themselves struggling to get schoolwork done on time and keep on track with their goals. Conversational agents, or “chatbots,” are becoming increasingly prevalent, and can be used in a variety of ways. One of these applications is mental health support.

The purpose of this study is to design and develop a conversational agent to assist students during distance learning by helping with time management, goal setting, and maintaining healthy habits. After communicating with high school students and teachers in order to determine some of the most prevalent challenges faced by students, Mindmeld, a Python-based platform for building conversational agents, was used to create the chatbot, which can store user-inputted information such as an event or homework due dates along with when the user wants to receive a reminder. The project goals were achieved with a tool that can effectively aid students in time and project management.

Even after the pandemic ends and students return to in-person instruction, there will still be a need to support students during this busy and challenging time of their lives. This study points to the immense potential of chatbots to serve as tools for students, supporting them in their goals and aspirations in high school and beyond.

Examination of Natural Language Processing for Courtroom Semantic Analysis

Steven Wang

As technology rapidly increases the speed of data collection and processing, it is necessary to create tools that can discern information and form conclusions. In the courtroom, an undercovered area of study, attorneys must analyze legal documents with speed and precision, though this proves increasingly difficult. In order to address this issue, computer scientists view computational linguistics as a potential solution to the problem of courtroom efficiency. By creating Natural Language Processors (NLP) that can semantically read through documents and gather main ideas based on a specific prompt, researchers can create real-world tools to improve the legal process. The objective of this study is to create a prototype Natural Language Processor that can comprehend linguistic data through vector space models. This will be done through the development of semantic-based programming software, code tailored to the legal process, and extensive testing of linguistic models and semantic similarities.

ProFit: introduces a new way to seek and complete daily paid jobs.

Rita Li

The unemployment rate has risen significantly during COVID-19 all around the world including America. Research has shown that the unemployment rate for the first three months of COVID-19 in the U.S. rose higher than two years of the Great Recession. According to "the balance", U.S.'s unemployment rate was still at 6.3% in January 2021. The rise in the unemployment rate has strongly impacted America's economy. As an effect, the US government had to provide many stimulus fund packages for small businesses. Already large in debt, the US has already reached nearly $27.78 trillion debt in 2021.

We all know stimulus fund packages can't last forever. To solve this issue, I will introduce a new way for people to seek and complete daily paid jobs through an app called ProFit. ProFit will be accessible for everyone. It is an app developed to help businesses seek their "best fit" workers. ProFit allows businesses to assign daily tasks and people all around the nation can access and complete them with daily payments. ProFit is designed to be very flexible and manageable. One can easily switch from one job to another because each payment is paid one task at a time. Since ProFit is so flexible, one can complete their tasks almost at any time and anywhere as long as one doesn’t violate any policies and turn in their work on time. ProFit is also very easy to use just like any social media apps. It is designed in a way so that workers can directly contact businesses and find jobs that fit them the best.

Not only will this app help America's economy become better, but ProFit will also introduce people to a new way of life.

ICU Car Sentry: An Intelligent Car Safety System

Riddhi Singhvi

Personal safety is of paramount importance for all of us. In US, about $6.4 billion was lost to motor vehicle theft in 2019. The average dollar loss per theft was $8,886. Motor vehicles were stolen at a rate of 219.9 per 100,000 people in 2019. More thefts of cars are reported than theft from within a car. Most car security is inadequate, even though newer cars are equipped with Wi-Fi and up to 10 cameras. They only achieve the goals of car safety in motion, but not at rest. In and around car safety has gained a lot more importance in 2020 due to Black Lives Matter (BLM) and other protests. This research is focused on making in and around cars a lot safer place whether a car is in motion or at rest for 24 hours. The system was constructed using wireless cameras which act as an access point (AP) for the cell phone in the car. Since each camera is a separate access point, the system itself was very fault-tolerant and malfunctioning of one camera did not affect other cameras. Six cameras gave the highest level of monitoring with overlapping views at night. The cell phone acted as a digital storage device, an alert gateway, and a Wi-Fi hub. The system was tested in a Sports Utility Vehicle (SUV). The system was fault-tolerant, performed during day and night, with the car being on/ off, and also successfully detected motion around the car in total darkness.

Artificial Neural Network News Sentiment and Keyword-Based Stock Price Prediction

Alexander Soltau

Recently, the capabilities and variety of neural networks has expanded dramatically. This explosion has opened up new potential applications of Artificial Neural Networks (ANNs) to previously unsolvable problems. This study proposes research into the optimal configuration of neural networks, training data, and data processing in prediction of stock price graphs with the use of external news-based information. The proposed method begins with the collection and manipulation of large amounts of data that will be fed into the neural network. Subsequently, the news-based information is created from analysis of collected news articles. Once that is done, multiple variations of neural networks, all with different training data and natures, are trained and tested on their ability to predict historical prices of various stocks. By analyzing the successfulness of these variations, the theoretical ideal combination of all variations is established. Finally, the theoretical ideal model is trained and tested to allow for final analysis. This research has amazing potential in the field of stock market analysis, and could yield new insights into the prediction of human behavior.

Rapid development of 3D worlds

Kiefer Miskiw

As 3D worlds become more and more complex and detailed, the need for a faster development time to fit budgets becomes necessary. But, as the need for more complex worlds has increased, the software used to create these worlds has not become faster to accommodate. These programs mitigate the work of the level designer to a 3D modeler (Epic Games, Inc., n.d.) and increase the time of development by taking the brush out of the painter's hand . This problem and separation can be solved by bringing back the tools to create worlds into the hands of the level designer. With a level designer able to take ownership of a design, the time to completion can decrease, and the vision of the world can be how it was meant to be. A piece of software will be constructed with the goal of allowing the designer full control over the mesh of the world with strong tools to allow for faster creation and modification of geometry to be exported to any standard 3D map format.

W-HS-SOFT-0053

Systems Software

Improving the efficiency of sanitizer-guided fuzzing through libFuzzer-style in-process mechanisms

Jack Wherry

The purpose of this study is to devise a system that can efficiently uncover security vulnerabilities in real -world software. It builds on existing work in fuzzing by building a program that uses coverage and sanitizer guidance to mutate inputs to a computer program to test code with potential bugs (Österlund 2020, Chen 2018). This research may be able to decrease the prevalence of critical zero-day vulnerabilities in software used by millions of people. To achieve this, the researcher seeks to combine sanitizer guidance, where a fuzzer is guided towards areas of code that have sanitizer instrumentation, with in-process fuzzing (a strategy used in large, existing projects like Chromium). The researcher will develop a fuzzer that meets those requirements and test it on a variety of real-world and synthetic targets.

A Schedule a Day Keeps the Doctor Okay: An algorithmic and user-friendly approach

Caroline Pirtle

Sahana Mangipudi

One of the challenges in a clinic environment is optimizing schedules for medical residents so that patients receive consistency in care. Typically, residents have inconsistent clinic shifts, inadvertently preventing patients from seeing the same provider at each visit. This decreases the quality of patient-resident relationships and inhibits the development of residents' clinical skills. In this research, we focused on improving the overall clinic environment by optimizing the number of shifts assigned to residents per month. We analyzed historic data from the Phalen Clinic in St. Paul, Minnesota to identify tangible aspects of resident schedules that could be optimized. We then created multiple algorithms, using Python, to optimize these objectives. In the final phase of our research, we developed a user-friendly interface so residents and medical directors can easily create their own optimized schedules using the algorithms we developed. Our interface has commercial potential to reduce the complexities of resident scheduling while improving the quality of healthcare outcomes.

Easing the facilitation and creation of scalable global internet based applications

Omar Elamri

The purpose of this study is to help developers rapidly create scalable applications on the global scale. Current research shows that today's methods are slow and inefficient—especially for mobile devices which are on the rise . If developers want their applications to be accessible to more users, current methods will have to change. This project will streamline the development of applications—in essence creating a one stop solution for all a developer's needs . Both the backend, frontend and database solutions will be abstracted to a singular framework. This will be achieved by creating a unified framework, translating presentation logic between device platforms, load balancing databases and servers, and finally creating serialization methods that allow for faster and more efficient data transfer . Once this is completed, a demo application using this new framework will be created to showcase it.

WI-CARE: Wifi Computer-Assisted Remote Eldercare (Year 2)

Shreshth Shrivastava

As America ages, it's estimated that by 2021, nearly 45% of the country's population will be over the age of 50. While retirement years may be filled with travel, hobbies, and time with family, it is also traditionally a time of increasing healthcare needs and decreasing independence. COVID-19 has challenged the congregate care model, making it even more crucial to find effective solutions for senior independent living. The purpose of this study was to analyze what seniors need most to maintain their independence, and then to develop technology to directly address that need.

The research project has two main components:

Surveys were distributed to both seniors and healthcare professionals who work with seniors to gather input on how technology could be developed to provide improved care for seniors and help them live independently longer. This activity generated many ideas that can help guide priorities for this project both now and in the future.

A tool was developed using Arduino to track prescription consumption and timing using weight sensors that electronically communicate medication use to family members and doctors. Second a tool was developed that measures the distance from a cane or walker to another object, making a beeping sound if within 6 feet. This assists with both social distancing and fall prevention goals.

Both of the project goals were achieved. Next steps for the project include refining the tools and developing an alert system that reminds seniors to take their medications at the prescribed times, increasing their effectiveness.

D-PREDICT: An Artificial Intelligence Model for Predicting Likelihood of Early Stage Diabetes

Coolsjes Singhvi

Diabetes, a chronic disease, affected 425 million people in 2017 worldwide, with the numbers projected to increase at a rate of 7.3% per year. Early diabetes or Prediabetes is a condition where the blood sugar levels are higher than normal. Prediabetes progresses to type 2 diabetes (T2DM) in approximately 25% of subjects within 3–5 years, and about 70% of individuals with prediabetes will develop type 2 diabetes within their lifetime. Prediabetes has a relatively long asymptomatic phase and 50% of the cases go undetected. Early warning systems of prediabetes can allow a patient to make lifestyle changes that can slow down or prevent progression to T2DM. One such early warning model was developed based on Artificial Intelligence (AI). A newly published (July 2020) public dataset from the University of California at Irvine using 17 different attributes, all of which are yes/no questions outside of age, was used for model development. Random Forest, K-Neighborhood, Logistic Regression (two variations), Decision Tree Classifier (two variations), Gradient Boosting Classifier, Support Vector Machines (three variations), and Multilayer Perceptron (three variations) based Models were developed in Python using Google Codelabs. To reduce bias in the training data, the available data was split 50% each into training and test data sets to get the prediction accuracy for all optimized models. Random Forest Model had the best testing dataset accuracy of 99% with Gradient Boosting Classifier at 98.1% accuracy. Furthermore, the proposed HTML5 based system can be used by anyone, for free, to test for prediabetes.

Exploring Electroencephalography: Feasibility of EEG in conjunction to evaluation after sports-related concussion

Tanishka Mhaskar

Traumatic Brain Injury (TBI) is a silent epidemic; it has a high incidence, great potential for disability, and is not regarded as a serious issue despite proof for its adverse impacts. A combination of physical, cognitive, and behavioral symptoms form post-concussion syndrome. Usually, post-concussion syndrome resolves within a month, but sometimes it can last for a whole year or more, causing permanent disabilities and damage. To detect brain injury, electroencephalography (EEG) was developed 140-years ago. EEGs are very effective in identifying post-concussion syndrome (96% success rate), and neurotherapy, a type of biofeedback to illustrate brain activity, has been shown in several studies to be effective in improving the symptoms of post-concussion syndrome. This study aims to characterize the appropriate role of EEGs and why they are used in assessing concussions, treating post-concussion syndrome, and evaluating return-to-play time. A robust database was compiled from numerous published articles and queried to ascertain EEG applications and effectiveness .The hypothesis was supported, with the database supporting that:EEGs guide cognitive testing by using real time displays to illustrate brain activity, and •EEGs are a valuable tool for detecting concussions right after they occur or during post •concussion evaluation when determining return-to-play time because EEG analysis is more sensitive compared to cognitive testing. Given the debilitating potential of concussions, this work is critical in improving our understanding of the role of EEGs. The findings support their value in cognitive testing and better represent the health of the brain after a TBI , making return-to-play protocols safer.

The Spread of Macroscopic Droplets from a Simulated Cough with and without the Use of Masks or Barriers

Atreyus Bhavsar

One of the main challenges during the COVID-19 pandemic is the lack of safety measures and guidelines to reduce the risk of viral spread among people during gatherings. This study was conducted to evaluate the distance of oral and nasal droplet spread in a model that simulates coughing and sneezing in a public setting, specifically a school setting, to guide faculty and staff members with safety measures and guidelines to reduce droplet spread . Several models were prepared to observe and visualize the spread of fluid simulating respiratory droplets in places such as the classroom and the cafeteria, in which a student would be more susceptible to contract a virus since individuals cannot wear masks while eating. For all trials, a 2.54 centimeter balloon with 0.3 milliliters of diluted fluorescent paint was placed inside a mannequin head and was exploded outwards from the mannequin's mouth at 5 pounds per square inch (psi). Using a black light, the expelled fluorescent macroscopic droplets were visualized. When applying safety precautions and guidelines such as mandating face masks, the results of the experiments conducted in this study with a surgical mask, were extremely positive. However, without other safety precautions such as face masks and barriers, social distancing proved to be ineffective. In conclusion the most effective way to prevent droplet spread during activities where masks simply cannot be worn , such as eating, is to apply barriers between the individuals. Applying barriers and wearing masks successfully prevented macroscopic droplet spread.