

Junior Division Animal Sciences

Raeya Schrock

JR-AS-002

Infrared Thermography to Enhance Livestock Health

The purpose of the researcher's project is to become familiar with using thermography and interpreting thermograms as a useful tool for early detection of labor in heifers, heart failure in fat cattle and determining the extent of localized infection. It is predicted that thermal imaging will be able to detect health issues in beef cattle before the problems become apparent to the naked eye.

Thermograms were generated using a FLIR ONE Gen 3 Thermal Camera with a MSX Image Enhancement Technology Attachment. The researcher compared pallets "Contrast", "Iron" and "Hottest". Thermograms were analyzed to pinpoint inflammation and identify animal distress.

Infrared thermographic technology is most accurate and useful at identifying localized inflammation and infected areas where as the accuracy diminishes with distance from the animal. Thermography pointed inside the ear proved to be an accurate indicator of animal temperature. The "Contrast" setting proved more detailed compared to the "iron" pallet.

Dorothy Berger

JR-AS-003

Pet Stress Management with Music

The number of puppies being adopted has dramatically increased in the past year due to the pandemic and many people being stuck at home. The new dog owners are going to need ways to calm and reassure their pets. One easily accessible way is playing music or sounds for the dogs. Little research has been conducted on which specific sounds are calming to dogs in their own home environment. Dog owners in the community were recruited and sent instructions to expose their dogs to four different sound conditions. The four conditions were upbeat music, calm music, classical music, and nature sounds. The owners observed their dogs and recorded their observations before, during, and after the sounds were played. The data was then analyzed for differences in the dogs' behavior, vocalization, and activity level. All of the sound conditions had an impact on the dogs' activity level. The calm music (link D) and the upbeat music (link B) both had a slight decrease in the dogs' activity level. The calm music decreased their activity by 18% and the upbeat music decreased it by 16%. The nature sounds (link A) were the most calming sound condition with a 31% decrease. The classical music (link C) had the opposite effect and increased the dogs' activity level by 46%. The results suggest that nature sounds have the most significant calming effect on pet dogs in their home environment. Pet owners can use this strategy to help calm down their dogs.

Aleigha Sanchez

JR-AS-004

Searching for the Earthworm's Home

The terrestrial invertebrate known as the earthworm is often ignored but the significance of the soil-dwelling detritivore is not. They are a necessary part of the ecosystem in that they recycle nutrients back into the soil. In order to preserve the species, it is important to know in what soil the earthworms feel the most comfortable. The more comfortable they are, the more likely it is that they will continue to fill their role of keeping the soil fertile. When I was younger my brother and I would go out in the garden and dig up worms for my grandpa to use as bait for fishing. Every time we collected the worms, I wondered why they were in that soil. I did this project so I could know what type of soil the earthworms preferred. I tested 24 earthworms, in 3 groups of 8, to see what type of soils they preferred by letting them choose out of four types of material that can make up soil - dead leaves, potting soil, sand, and gravel. While many of the worms preferred the dry leaves, the results showed that the majority of the earthworms preferred the sand over the potting soil, leaves, and gravel.

What Color Is the Most Appealing to Horses?

The purpose of this experiment was to find what color is the most appealing to horses. Horses have a dichromatic vision which means they only see green and blue colors of the color spectrum; they cannot see red. This will help people feed their equine friend medications or other feeds that are necessary because the owner will know what color to use to make what they are feeding seem more appealing to the animal. I hypothesize that if I place three different colored tubs, red, yellow, and blue, in a small lot with a horse, then most of the horses tested will walk towards the blue tub. I will run this test with eight different horses.

I placed three different colored buckets, red, blue, and yellow, in a small lot with grain in them. I caught the horses one at a time and turned them loose in the pen with the buckets. The horses then walked to the bucket of their choosing to get a tasty snack.

The data from the experiment showed that blue was the most appealing color with 50% of horses going to that bucket. 25% went to the red bucket and the other 25% went to the yellow bucket. This leads me to conclude that blue is the most favorable color among horses.

Big or Small, Noise Affects Them All

The question I had was, "I know dogs react to noise, but would smaller dogs react more anxiously than larger dogs.?" The prediction I had was, "If a small dog and a large dog were exposed to the same sound, then the smaller dog will have a more anxious reaction to sound than the larger dog." Then the materials were gathered. Next, I reviewed my research plan. The study displayed the reactions of all the dogs I tested. The animal was singled out, the sound was started, took pictures, and recorded the data. Then the data was looked over. The data displayed that my hypothesis was correct. The smaller dogs had a more anxious reaction than the larger dog.

Junior Division Behavioral & Social Sciences

Mahi Mehta & Shriya Sriram

JR-BSS-001

The Effect of Age and Gender on Body Image Perception

Affecting many globally, the body image issue is stigmatized, promoted by media tendencies. To further understand this, we tested the effect of age and gender on body image perception, by giving a survey to male and female students in grades 5-10, which consisted of 8 questions regarding 4 categories: ideal weight, age, height, and muscularity. We had two questions per category, one for each gender tested; silhouettes were used for all questions, to limit outside factors. The results showed that an average of 82.2% of students preferred the option healthy/skinny body weight, an option showing weight on the lower side of healthy. For preferred age, a majority of students choose teenage, with the exception of 9-10th graders who preferred middle ages, an option representing people around the ages of 25-50. Medium muscularity for females and muscular for males was most preferred, with the option muscular showing the second most amount of muscle, and medium muscle showing the second least amount of muscle. One noticeable trend was higher preference for taller males and shorter females, although medium height was the most preferred overall. Also, older ideal age was mainly preferred by older students and all tested genders preferred higher muscularity for males. Some of these results supported our hypothesis, which predicted a preference of 'skinny' weight, 'tall' height, 'teen' age, and higher muscularity for males, lower for females. Some results differed, such as our height results. We explore possible reasons that our results differ from expected trends.

Phoebe Donovan & Lola Green

JR-BSS-002

The Cover Up: The Relationship Between Face masks and the Perception of Facial Cues

Do face masks affect perception of facial expressions? We hope to discover whether masks impact people's understanding of facial cues. If mask-wearing is related to perception of facial cues then mask-wearing will decrease understanding of facial expressions. We think participants will have more difficulty understanding facial expressions of people wearing masks, because masks cover half the face, so not all of expression is visible, and only part of cue can be interpreted.

Participants correctly interpreted facial expressions of masked photo subjects 32.4% of the time. They correctly interpreted facial expressions of unmasked photo subjects only 24.9% of the time. This disproves our hypothesis. We discovered that people more accurately interpret facial expressions when someone is wearing a mask. Our findings help people understand how well others interpret their nonverbal facial cues, and make adjustments to be better understood.

Collective and Swarm Intelligence: Are Many People Really Smarter Than a Few?

Experiments have shown that the average of a bunch of people's guesses are more accurate than that of a small group of experts. Smaller groups have less diversity. I showed 90 participants, in three different groups, a jar of marbles and they guessed the amount. Using this data, I computed the average and standard deviation. I compared the different groups' guess averages versus the true value to determine the accuracy. I also compared the standard deviation to the accuracy to determine whether they were correlated.

Swarm intelligence, where a small group of people form a consensus based on other people's guesses, was said to work well. I conducted the swarm intelligence experiment with seven people only showing them the average until it didn't change any more. I measured the standard deviation of different groups versus their accuracy to test if this was really the case. My test questioned whether swarm intelligence, or collective intelligence, was more accurate. My theory is that the population with the highest standard deviation will have the highest accuracy, and that Swarm intelligence will be more accurate than collective intelligence, because participants will be able to adjust their guesses based on other participant's guesses. The group with the highest standard deviation, had the most accurate average. The swarm intelligence group's average is the most accurate of all. An aspect of my results was that almost everybody guessed low. Most guesses were 50- 100 marbles off. How perfectly the marbles were able to fit together was deceiving.

No Pain Lots of Game

Have you ever wondered why the dentist has you watch a movie while they work on your teeth? They are trying to distract you from the teeth pain by having you watch a movie. Doctors also help patients with severe burns by having them play video games.

In a study in 2012 to help burn patients, doctors used a game called SnowWorld to try to distract the pain from forms of burn-related treatments. These treatments such as wound scrubbing, dressing removal, are very painful and hard to go through. The game was quite effective in helping the patients cope with their pain. In some burn patients, the game was more effective than morphine.

There was another study conducted by a group of doctors to see if audio distraction would decrease anxiety pain and bad behavior during youth dental procedures. During their first visit they had a regular dental appointment and then during their second appointment were assigned a music group. The audio distraction did not work in terms of reducing anxiety pains or bad behavior. It was noted that the patients did enjoy the music. In this experiment the researcher will be testing this theory by testing their pain tolerance with and without a board game. The purpose of this science experiment is to increase pain tolerance by distracting the brain. The researcher predicts that subjects will be able to handle their pain longer while distracting their brain with a board game.

The Key to Focus

Do breaks really help you focus? I thought they do, based on my research our brains need breaks to send blood flow and oxygen to the brain for it to completely work well. So, to test this knowledge, I gathered 3 students, and tested them before and after their break then compared their test results each time, to find that person A received 54/80 correct the first time, and 55/80 correct the second time. Person B received 51/80 the first and 50/80 the second, but person C, with most improvement, received 57/80 the first, and 67/80 the second, much more than before. With these results, it has proven my hypothesis correct, that breaks are the key to focus.

Psycho-color

My project was Psycho-color. I made a survey to test if pattern affects the way people feel about certain colors. I thought that color would be the same no matter the pattern (or lack thereof), but my hypothesis was wrong and the patterns did make a difference. I tested it and got less results than I hoped I would, so next time I would find more people.

Teen Mental Health

My research question is, how has COVID-19 affected teens' mental health in 2020? My hypothesis for this question is, I think that COVID-19 has majorly affected teens' mental health in 2020 because of the stress and anxiety that quarantine has brought upon them. For this project, the methods I have used are, gathering my contestants, handing out surveys, receiving my data, and analyzing my results. The results for my project were that COVID-19 has affected teens' mental health, but it has also affected their social and physical health. I also noticed that COVID-19 has caused most teens to become more lazy and less productive because of the multiple stay at home orders. In conclusion, I accept my hypothesis because my graphs have shown the difference in mental, physical, and social health amongst teens' through the age 12-18.

Does Practice Really Make Perfect?

We have all heard the saying, "Practice Makes Perfect", but does it really? And what about when it comes to using fine motor skills like playing a guitar?

I took two similar songs from Metallica and practiced them for four weeks two different ways. Once I got the music, I played a page from each song and recorded myself so I could count mistakes and see how long it took to get through them. I then began practicing. The first song, "Nothing Else Matters", I practiced 15 minutes a day, six days a week. The second song, "The Unforgiven", I practiced 45 minutes a day, once a week. After the four weeks, I recorded myself once again playing each song. I then compared my first recordings with my last recordings.

I found that practicing did help build strength and agility in my fingers, so practicing did in fact improve my fine motor skills. I also found that practicing a little every day was better because I was able to play the song almost perfectly with the movements of my fingers becoming natural with little thought. Therefore, practicing does make perfect with the right amount of practice and with the proper technique.

Psychology of COVID-19 Vaccine

There are many different perspectives on coronavirus vaccines. Even though the majority of Americans - around 60% (Funk & Tyson, 2020) - are willing to take the vaccine, there's still concern. Similarly, many things like a person's age, gender, ethnicity, income level, and political views affect your beliefs and thoughts about the coronavirus and the vaccine. Therefore, the purpose of this study was to ascertain if someone's age, gender, race/ethnicity, and health problems will affect willingness to take the coronavirus vaccine. An online survey was used to determine if a correlation exists between these factors and someone's willingness to take the vaccine. The results reveal that nearly 80% of people are willing to take the vaccine. The three main factors that showed correlations, were political views, ethnicity, and age. Survey respondents from Democratic states were more likely to take the vaccine than Republican states, Hispanic and Latino people were less willing than non-Hispanic or Latinos, and older people were more willing than younger people. Future experiments could include other characteristics of people, like their religion, sexuality, and level of education. This data could demonstrate certain inequalities in the world, which can be managed.

How Do Artists Coordinate Color with Mood?

The purpose of this project was to see how artists use color to bring out moods in a person. I hypothesized that artists use different colors in their artwork to make the viewers feel different moods.

The experiment involved me showing people the same drawing but in different colors, primary colors, secondary colors, and black and white.

In conclusion, the data supported my hypothesis which stated that artists use certain colors to make a person feel certain emotions. For example, when I used the colors black and white, 100% of people felt sad. When I used the color green, 100% of people felt happy. Another example is when I used the color yellow, 66% of people felt happy. One last example is when I used the color purple, 66% of people felt happy. These were my intended feelings for these colors.

These findings led me to conclude that artists do indeed use different colors to make people feel different emotions.

The Perception of Taste

What effect does the color of a drink have on the taste? Sight is one of the first things that identifies foods or drinks. Taste, sight, and smell are senses that help you taste.

My hypothesis is that the Red drink will be liked most. To test my hypothesis, I used apple juice and added blue, green and red food coloring to it. The point system used was 3, 2, and 1, with 3 for the volunteer's favorite.

Twenty-three people were tested. Using the point system, Red and Green scored 48 points and Blue 42 points. Another way to look at it is the overall favorite: 10 liked Red the most, 9 liked Blue, and only 4 liked Green. Looking at the ranked favorites, Green had only 4 favorites, but tied with Red on total points because of the 17 second favorites, but Blue was chosen as 13 people's least favorite, so it earned less total points.

My hypothesis was somewhat supported because Red seemed to be the most liked in each chart. The different ages seemed to have a huge impact on which drink was liked best. The older people seemed to pick the Red. The younger volunteers seemed to pick Green and Blue. The perception of taste using your sense of sight did not affect everyone's opinion, but it affected some greatly. In conclusion, I think that it depends on the person because there was not one drink that was greatly favored over the others.

Taste the Rainbow

My question is will color make people react differently to colors even though they taste the same. My hypothesis was that it was going to affect taste based on research. My brief description of my procedure is: I grabbed my ingredients and filled a bowl with water and put a few drops of dye in the bowl then I grabbed 30 marshmallows and dipped them in the water with dye and let it dry on a plate. My results were people reacted differently to the colors even though they taste the same and made my hypothesis right. My conclusion to my experiment was that color affects taste even if it tastes the same.

Essential Oils: What Essential Oil Calms the Human Body Best?

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Music in Creation

I did a science fair project on music that can be made with nature. I thought it would be easy and that music could easily be found in many parts of creation. I did not know that I would need to pull in a beat since I could not find a consistent one anywhere in nature. Once I added a beat there was many sounds I could have added in to create a song.

The Effects of Visualization

This experiment was testing whether or not visualization could benefit participants shooting free throws. The purpose of this experiment was to see if a person could get better by visualizing making free throws instead of actually shooting the free throws. I hypothesized that visualizing would help the participants make more baskets. For this experiment I took eight participants and had each of them shoot ten free throws. Then I had four visualizations for five days. After five days I had all eight participants shoot ten more free throws. Then I averaged out the ones who visualized and didn't visualize. The averages for the ones who didn't visualize did not go up or down. However, the ones who visualized went up by 5%. So, the conclusion was proved because the participants who visualized went up.

Junior Division Chemistry & Biochemistry

Mia Sholes

JR-CB-001

Surviving in the Winter Slumber-Land

If you really like the outdoors you most likely consider going backpacking. Some people even like going backpacking during the wintertime! But what some people don't consider is how dangerous winter backpacking can be. It just depends on if you can stay warm or if you get super cold. What you sleep on is vitally important! Most people bring pads with them when they go backpacking usually ones that get filled with air because they are light, comfortable, and easy to use. But they do not all keep you warm!

My project is to test lightweight backpacking pads and compare their performance with the R-value reported by the manufacturer. The experiment was done measuring the water temperature drop of 2-liter bags used to resemble the human body placed on different pads on a cold garage floor (7 degrees Celsius). I recorded the temperature every five minutes and watched the temperatures drop! My hypothesis was that pads with a higher R-value would perform better, and the bag of water would stay warmer longer because the material has been rated for its capability to insulate.

The studies showed that all the water temperatures dropped a lot over the entire 60-minutes, and some pads insulated better than others, but not as I expected. In the end, I found the R-Values in the pads don't really show the pad's true performance.

Pam Boyarko

JR-CB-002

Pam's Lemonade Laboratory

My project is on Butterfly Pea Powder. Butterfly Pea powder is a powder that comes from the *Clitoria ternatea*'s flower petals. It is crushed up and processed to make the powder. How I did my testing is by adding $\frac{1}{8}$ tsp pea powder to a glass of 8 oz. of tap water. I then take the pH of that water and the color. I then add in 0.5 oz. of lemon juice and record the pH and the color for that test. I do that process all the way up until I get to two oz. of lemon juice. I repeat that process for the Alkaline water as well. Then I do the same thing with the $\frac{1}{4}$ and the $\frac{1}{2}$ tsp of pea powder.

Haydan Drullinger

JR-CB-003

Keeping the Dust Out: Designing a Sealant

Technology is rapidly changing farming. With all the new equipment there is just one thing that needs to be addressed. The bearings. When farming in a field dust collects in the bearing and slowly breaks them down. The purpose of the project was to create a sealant that goes over bearings. The hypothesis was that a sealant with a high petroleum content would repel dirt, and water. Sealants were made with the ratios of 10/0, 9/1, $\frac{8}{2}$, $\frac{7}{3}$ parts petroleum jelly to honey wax. Ten samples of each sealant were made, five to be tested with dust particles and five with water. For each sample, either 5 grams of water or dust was applied to each massed test sealant, and allowed to set for approximately 2 hours. Then the sealants were hung vertically, allowing to drain, and the sealants re-massed.

Then measuring the amounts of water and putting it on. The sealant samples were shaken to remove the water and measure the amounts which gave the data, then the same was done with the dirt. The data showed that the pure petroleum jelly worked better than the mixtures with the honey wax because with the honey wax the water stuck more than the petroleum jelly.

Elephant Toothpaste

The purpose of this project was to learn more about exothermic reactions, hydrogen peroxide, yeast and how to experiment with chemicals. I hypothesized that the stronger volume or strength of hydrogen peroxide would produce the most foam.

This experiment involved mixing hydrogen peroxide, soap and food coloring in one bottle, then mixing water and yeast together, then I would mix those two substances together and it would create foam. After that, I would weigh and record the milliliters after two minutes, then I would let them sit, take the bottle out and weigh it and measure the height with a ruler. I then tested the other volumes three times each.

The data collected supported my hypothesis. The 40 volume (highest strength) produced the most foam. The third trial of the 40 volume produced the most foam out of all the trials.

These findings lead me to believe that if you want a bigger reaction of elephant toothpaste, you should make it with a higher volume of hydrogen peroxide.

Spherification

Spherification is a simple and exciting way to transform everyday drinks into interesting and unique edible spheres. Eating spheres of liquid is more fun and interesting than just plain old drinking from a bottle, so why not learn more about it, and how to do it? In the beginning, I thought adding in sodium alginate to different liquids with different pH levels would not affect my experiment; and it turns out I was wrong. In order for me to figure out I was incorrect, I needed to experiment. In order to experiment, I needed to make three sodium alginate liquid solutions along with three sodium chloride and water solutions, then drop my sodium alginate and liquid solution into the other solution with a plastic medicine syringe to create spheres. After I had concluded my experimentation, I came to the result that adding sodium alginate to different liquids with different pH levels does affect the quality of the spheres being made. It seemed as if the pH levels in all drinks reacted differently to the same amount of sodium alginate, which is why not all attempts went the same direction like I thought they would. Spherification fits right into the chemistry category and is immensely unique. Not many people know what it is, which is what makes it so interesting. It is a fairly short process, and is worth being patient. If you have been wondering how it is possible to create a sphere out of liquid, just keep reading.

Preventing Rust

How do we find out how to prevent rust the best? This project tests to see which of the four rust preventers works to protect the metal. The prevention process was tested in a small plastic tub on a 7 by 5 centimeters steel plate for 4 days. My hypothesis was that the Rust-Oleum® would prevent all of the rust. The results showed that it didn't do as well as thought. The experiment showed that the beeswax did 35% better than the Rust-Oleum®. It was obvious that Rust-Oleum® was much more durable than beeswax, though, and a more practical coating for actual use. It would be interesting, though, to study wax coatings further given the results of these experiments.

Stretchy Slime: Which Slime Stretches the Farthest?

I did my topic on slime because I was interested in chemical reactions, and slime is a basic chemical reaction. I did a lot of research and picked my top four slime recipes. Then I made a hypothesis that the slime with lotion would stretch the farthest. My plan was that we would go up to a high height and drop each of the slimes from the top and measure how far they stretched. I made four slimes. The pink, which was my basic slime, the blue, which was the one with lotion, my peach, which was the one with shaving cream, and my purple one that was the clear slime. My first experiment was right after we made the slime. I was right that the blue with the lotion stretched farthest. My second experiment was to do the same thing just a month later. To my surprise, the blue one was hard and stiff. My conclusion is that the lotion dried up in the slime making it less stretchy.

What State Is Oobleck?

My science fair project was about oobleck. Oobleck is an object which can take the form of a liquid and a solid depending on the situation that the Oobleck is in. Oobleck is consisting of cornstarch and water, but for my experiment I used different ingredients to see if it would put a different affection on the Oobleck.

For my science fair experiment, I made three different types of Oobleck. All the three different types of ooblecks have different ingredients. I changed one subject matter to see how effective much it would be effective to the oobleck. The first oobleck I made consisted of cornstarch and water. The second oobleck i made consist of milk and cornstarch, and the third Oobleck consisted of water island flour.

I made all of these ooblecks then compare and contrast the ooblecks. Once I had done all of my procedures of making the Oobleck I boiled each individual Oobleck and made a separate batch of the same ingredients of Oobleck in repeating the process but instead of boiling the oobleck like last time I froze the oobleck.

In conclusion I use different experiments in changing the subject matter of Oobleck or ingredients to see what state the Oobleck was going to be by putting like three different tests to see the reaction of the Oobleck to connect it to other objects in which people determine what the object state is.

Melting Ice

What material would melt the ice the quickest. The magnesium chloride would melt the quickest. Put a piece of ice on a flat surface and put a material of your choice on the ice and then time it. Do this with all the materials. The magnesium chloride would melt the ice the quickest. That my hypothesis is correct and the magnesium chloride would melt the ice the quickest.

Charcoal Challenge

How does what we use to purify affect the quality of our water? Based on my research, I think that the commercial water filter will filter the water better. I took a liter water bottle and cut off the bottom. I then placed Polyester fluff, charcoal, sand, and gravel in it in that order. Then I let water run through it for about 20 minutes to clean any debris. I took my commercial filter (iSpring) filter and tested a sample from 1 year of use, then changed the filter and tested it again. Tap water was my baseline for this project. I collected my sample from my homemade filter and analyzed all of the samples using a TDS meter. The tap water (Baseline) was 110 TDS; My homemade filter got an 81 TDS reading, and both commercial samples got a reading of 4 TDS. The commercial water filter got a better reading than my homemade filter, so my hypothesis was correct.

How Does Pain Medication Affect Your Stomach?

Our stomachs are a vital organ in our body. It produces acids and enzymes to break down food. In order to do so it has to have an extremely low pH balance. A healthy pH balance in the stomach is around 1.25 to 2.25. Keeping a normal balance is important because it's our first defense against bacteria in the body. My hypothesis was that medications (Acetaminophen, Ibuprofen, and Naproxen) will lower the pH balance in the stomach. The purpose of this project is to determine how different over the counter painkillers affect the stomach's pH balance. I predict that based on the capsules and how they are coated will determine how fast the drug changes the pH of the stomach. To collect data, I used a Vernier pH monitor to measure the pH balance of my mock stomach acid after I had dropped the medications in the solution. I checked the pH in 5-minute increments for 45 minutes. In my result I found that all the medications dropped the pH. My hypothesis was supported.

Glow and the Flow

The purpose of this project was to find how temperature affects the glow brightness of Bioluminescent Dinoflagellates. I hypothesized that that the Bioluminescent Dinoflagellates at higher temperatures of 70-75 F and 80-85 F would glow brighter than the Bioluminescent Dinoflagellates at 60-65 F, as they are able to reproduce more at higher temperatures. To test this, I separated a wooden box into 3 compartments with different temperatures and placed Bioluminescent Dinoflagellates into each, then I tested the glow brightness with a LabQuest and a Light Sensor. From my data I found that my hypothesis was rejected, as the lowest temperature of 60-65 F made the Bioluminescent Dinoflagellates glow the most at an average of 0.29 lux, 0.09 lux more than my control of 70-75 F. My data also showed that my highest temperature glowed the least at only 0.19 lux. My data could show how temperature affects Bioluminescent Dinoflagellates. However, I don't trust this data, as it does not match what I directly visualized. I noticed that the Bioluminescent Dinoflagellates at 70-75 F glowed very little to almost none, and the 60-65 F and 80-85 F Dinoflagellates glowed around the same.

Proteolytic Enzyme Power

Whenever you eat the fruit pineapple, you seem to have a fuzzy feeling on your tongue. Have you ever wondered what it was? It is because of an enzyme called bromelain. But how does bromelain work? How does bromelain affect you?

How will this proteolytic enzyme work in different temperatures and pH? How does it break down the proteins in the body? I did a total of three experiments to test the activity of bromelain in different temperatures, different pH, and which different juices I should use to get the most bromelain. I thought that in the first test, bromelain would be most active in temperatures near the body temperature, 37°. I believed that in the second experiment, bromelain would be most present in fresh juice instead of canned juice. In the third experiment I believed that the less acidic and more basic pH would have the most bromelain activity.

In the temperature test, I decided that I would test the pineapple juice with bromelain in different temperatures and how it reacts to a film strip and compare it to my control, or the pH 3 buffer. I would also compare the results of one temperature test to the results of all the other temperatures. After the test, I discovered that the temperature in which bromelain is most active is from 30°-50°. In the second experiment I decided that I would test canned pineapple juice and fresh pineapple juices effects on gelatin. I compared the result with my control, plain gelatin. After my experiment I discovered that the fresh pineapple juice had the most bromelain present, as it broke down the gelatin. In the preparation of the third experiment I tested the pH of different chemicals with an without bromelain and compared the results. I discovered that in the less acidic and more basic chemicals bromelain turns it into a more acidic pH. In the third experiment I tested how bromelain in different chemicals catalyzes film strips compared to the chemicals without bromelain. I discovered that in the less acidic and neutral pH is where bromelain is most active.

Overall, my hypothesis was supported. I believed that bromelain would be most active around body temperature and this was supported by my experiment. I also believed that bromelain in pineapple juice would break down the proteins the most. This hypothesis was also supported by my experiment. In the third and last experiment I thought that bromelain would be most active in the more basic pH. My hypothesis was a little off on this experiment. Overall though, my hypothesis was almost completely supported.

The Effect of Essential Oil on Ascorbic Acid Decay in Citrus Juice

The goal of this project was to see if the addition of wild orange essential oil to freshly squeezed orange juice may help to slow down the decay of ascorbic acid when exposed to various temperatures, allowing vital nutrients to be maintained and providing a natural alternative to the chemical additives being used today.

Ascorbic acid, known as Vitamin C, is an essential nutrient for human beings to stay healthy, especially during the time of the COVID-19 pandemic and for those who still struggle with scurvy disease. Ascorbic acid, by nature, is not stable. Once an orange is peeled or juiced and exposed to environmental factors such as temperature, oxidation occurs. Wild orange essential oil has purifying and cleansing properties which has the potential for being a natural food preservative.

I hypothesized that the addition of essential oil to freshly squeezed orange juice would slow down the rate of oxidation when exposed to various temperatures, reducing ascorbic acid decay. An iodine redox titration was used to measure ascorbic acid across four different wild orange essential oil concentrations and four different temperatures.

Data was collected and then used to compare the samples with essential oil added to the control samples. On average, wild orange essential oil slowed down ascorbic acid decay in freshly squeezed orange juice by 15% at the three highest temperatures tested. These positive results provide a lead into future exploration for the use of natural preservatives to maintain vital nutrients for human beings to stay healthy!

Identification and Characterization of the Natural Sweetener: Brazzein

It is well known that overconsumption of sugar can lead to obesity and diabetes. American obesity rates reached 42.4% in 2017 and 34.2 million Americans had diabetes and 88 million American adults had pre-diabetes in the year 2020. Sweeteners are good sugar substitutes, however, many of the current sweeteners have drawbacks, for example honey is caloric and other zero-calorie sweeteners have bitter or metallic aftertastes. In this study, a new sweetener candidate called Brazzein was introduced and its thermal stability was tested. Brazzein is a natural protein that has a sugar-like taste with zero calories. A series of tests were conducted in order to determine Brazzein's thermal stability over a broad range of temperatures and incubation times. This study shows that Brazzein's stability decreases as both temperature and incubation time increase. Brazzein was able to maintain 100% stability at room temperature for 48 h and 80% stability at 70°C for 5 h; and its stability significantly drops when the temperature is above 80°C. It was only able to maintain 80% stability at 90°C for 30 minutes and 100°C for 10 minutes. These results suggest that Brazzein is suitable for ice cream, desserts, and cold and hot beverages, but not for baking or boiling.

Putting Apples to the Test

The purpose of this project was to figure out which substance kept apples from browning the longest. I hypothesized that the lemon juice would be the substance that kept the apples from browning the longest.

To do the experiment I sliced the apples into eight equal pieces, then I added different substances into each of 7 glasses. Then I placed an apple in each of the 7 glasses. I left them there for 24 hours before investigating my results.

The data that I collected brought me to the conclusion that my hypothesis was correct. These findings led me to believe that lemon juice keeps apples from browning the longest and vinegar causes the apples to brown much more quickly.

Popped Perfection

The purpose of this experiment was to determine whether increasing the protein content of the flour can affect the height and volume of a popover. I hypothesized that if I increase the protein content of flour then the popover's height and volume might increase because adding more protein can provide more structure as the steam from the milk expands the popover. My independent variable was the protein content of flour and I used 3 different types of flour, including cake flour (8.5% protein), all-purpose (11.7%), and bread flour (12.7%). I made 24 popovers for each flour type, making them in batches of 6. Then I measured the height with a combination square and the volume using the method of volume by displacement of each popover. Cake flour resulted in the smallest volume and height. All-purpose flour and bread flour resulted in similar height and volume. In the end it showed me that if you increase the protein content of flour then you will create a bigger volume and height of a popover.

The Way the Cookie Crumbles

The purpose of this project was to find out what the majority of people like in their cookies butter or shortening. I hypothesized that the shortening would make the cookies puffier/softer. The experiment involved making cookies, having people try the cookies, and collecting the data to see which people would like in their cookies more. The data collected did support my hypothesis. Using shortening did result in puffier softer cookies. Based on the data the cookies tasted with shortening in them were puffier. These findings lead me to believe that shortening is better if you want softer or puffier cookies.

Chemical vs. Brun

The purpose of this project was to determine if bleaching your hair will damage it more than straightening your hair. I hypothesized that straightening would damage hair more than bleaching. The experiment involved bleaching part of the wig and straightening the other part of the hair to see which method is more damaging to the hair. The data collected did not support my original hypothesis. The data I collected from my project shows that my hypothesis was incorrect. The bleaching was way worse than straightening the hair. These findings lead me to believe that bleach damages hair more than straighten does.

Bread to the Gluten to the Free

The purpose of this project was to determine which gluten free flour is most similar, in nature, to regular flour when baked in bread. I hypothesized that the almond flour would have the most similar flavor, crispiness of crust, fluffiness, and texture, to regular flour.

This experiment involved baking the four loaves of bread; these loaves were baked with regular flour, oat flour, almond flour, and rice flour. Then I directed the three judges and me, to consume the bread and judge them on the rubric.

The data collected did support my hypothesis. After creating the four loaves of bread, including, regular flour, rice flour, oat flour, and almond flour, the other judges and me, determined that the almond flour loaf, was the one that compared most similarly with the regular flour. Because of this discovery, I would use almond flour in place of regular flour instead of any of the other options.

I learned a few things about how I would make gluten free bread differently. I would find better recipes that I knew would work for gluten free flour, and regular flour recipes. I would also compare good recipes for each bread. Something else I might do differently is find gluten free blends, instead of pure gluten free flour.

Glowing Quinine

My question is how does temperature affect quinine? I think quinine would stop glowing if temperature was raised to 212 degrees Fahrenheit. From my research I thought salt and bleach would eliminate glow and I thought freezing quinine would not affect the glow. The quinine still glowed after boiling. It boiled at 180 degrees Fahrenheit which was unexpected because the normal boiling point of water is 212 degrees Fahrenheit. After further research I found that the boiling point changes with altitude. Salt and bleach when added to quinine take away the glowing properties. I also decided to boil and freeze the tonic water and record the temperature. I thought quinine would stop its glowing when boiled.

Junior Division Earth & Space Sciences

Gurman Goraya

JR-ESS-001

Stellar Endgame

My project is about how stars vanish. All stars disappear in a spectacular way, but stars that 'go out with a bang' are my favorite: supernovas. The purpose of the experiment was to understand supernovae and how they work. I've always been interested in space, and so this was a way to learn more about the universe.

Drop a basketball, soccer ball, tennis ball, and ping-pong ball from a height of 3 feet. Measure how far the top ball went from the place it was dropped at. Do this step as the top ball being a soccer ball, tennis ball, and ping-pong ball three times each.

As it is evident from the results, the more balls (meaning more mass), the greater the distance traveled by the surface ball(meaning more energy dissipated.) This is what I expected.

In conclusion, these results confirm the research that has been done by scientists. My hypothesis was confirmed by my research which stated that the greater the mass, the greater the explosion. The study of stars and supernovae can be applied by scientists to further explore the universe!

Aidan Baar

JR-ESS-002

Will Different Soil Types Effect Fertilizers?

Fertilizers are very important in agricultural Colorado. Many things can influence the effectiveness of a fertilizer. This project explores if the type of soil particle (sand, silt or clay) influences how much fertilizer is retained in the soil. It was hypothesized that due to the large size of sand particles, and the amount of space between them, more of the nutrients from the fertilizer will pass through the soil, and that the shape and charge of the clay particles, would cause more of the nutrients from the fertilizer to remain in the soil. This was tested by constructing soil columns containing sand, silt or clay particles. For the control test, the nitrate and phosphate levels were tested in water drained from columns without fertilizer. Two experimental tests were conducted, one with application of fertilizer on dry soil and one on wet soil. Drainage water from each column was collected and tested for nitrate and phosphate levels. The data collected indicates that the hypothesis about sand was not supported. Both nitrate and phosphate levels decreased in the drain water of the sand following fertilizer application, which means the ions were held in the soil. The hypothesis about the clay particles was supported for nitrate in the wet application but not in the dry application. This hypothesis was not supported for the phosphate because there were more ions in the drain water indicating the soil could not hold on. Since the data collected does not agree with published research, more trials should be done.

Ronan Curnyn

JR-ESS-003

How the Size of Earthquakes Affects the Size of Tsunamis

The purpose of this experiment is to find out how the magnitude of underwater earthquakes affects the size of tsunamis created by them. Hypothesis: The size of underwater earthquakes affects the size of tsunamis. Prediction: I think that the bigger weights will create larger waves. This is because the heavier weights will be dropped at a higher velocity, which will then make the tsunami simulator move more, which will create a bigger wave. The smaller weights will drop at a slower velocity and they will make a smaller sized wave in the simulator. To test this, I made a contraption and used three weights to make a wave. I then measured the size of the wave to determine the effect. The 8-pound bag of water created the largest wave at an average of 7.33" high, followed by the 6 pound bag at 5.33" high, then the 4 pound bag at 3" high. This demonstrates that a larger earthquake will cause a larger tsunami.

How Does Unnatural Light Pollution Affect the Visibility of Stars?

My science fair project is about how unnatural night pollution affects the visibility of the stars. I tested this by first, gathering my supplies (a toilet paper tube, a notebook, a pencil, and a flashlight, a toilet paper tube, a notebook, a pencil, and a flashlight). Second, I will prepare the notebook by putting in graphs for different locations including the location, description, star count, sum of counts, average count, and total visible stars. Third, I will go to the location, look through the toilet paper tube and write down the number of stars I see in the tube. Fourth, I planned to repeat this by slightly moving the tube and counting the stars again, I will repeat this nine times. Next, I would need to multiply the average count by 104 to predict the total number of visible stars in the night sky. I would also repeat steps 3-5 at 3 different locations. Lastly, I analyzed my data. The result of all this work was that unnatural light does affect the visibility of the stars because when I was around more lights I saw that there were less stars and when I was where there was no light I observed that there were way more stars that I could see.

Earth's Layers Under Pressure

I chose this project because I wanted to make a model of the Earth's crust using layers of sand. I was curious about how the layers of sand would react under pressure. I hoped that my experiment would show a model of actual earth formations that were created under lateral pressure. I wanted to test the possibility of recreating a hogsback using lateral pressure.

The hypothesis of this experiment was proven correct. The speculation was that an earth formation could be modeled with a home-built compression box. As pressure was applied, a hard layer of sand started to crack and one part of the layer was forced under the other from the lateral compression. This created the resemblance of a hogsback. The experiment allowed the viewer to see a model of an Earth formation up close.

The Yellowstone Threat

The purpose of this experiment is to figure out how far the pyroclastic flow will travel from a Yellowstone eruption. To figure this out I got known eruptions from the past of Krakatoa and Mt. St. Helens and compared the prior eruptions to how far the eruption will go based on comparing the volcano sizes.

I built a scale model of Yellowstone, Mt. St. Helens and Krakatoa out of air-dry clay. I got the amount of water needed to show the distance of a pyroclastic flow from Mt. St. Helens and Krakatoa since these distances are known. Based on the size of these prior eruptions I confirmed the amount of water needed to make a scale representation that showed the correct distance for a prior pyroclastic flow. I took the water measurements from Mt. St. Helens and Krakatoa and scaled up from that to take the correct amount of water to mimic a pyroclastic flow. Mt. St. Helens took half a teaspoon of water, Krakatoa took $\frac{3}{4}$ of a teaspoon and Yellowstone took three cups of water.

Based on the scale model the Yellowstone eruption went 23 inches from the caldera. With one inch equaling three miles, the pyroclastic flow would have gone 69 miles from the eruption site.

I predicted 100+ miles for the flow, however based on my results I conclude it would likely be less than that distance.

UV Ray Extravaganza

Conducting my experiment, I tested how much UV radiation was attracted to white and pink shirts, the bright colors, and black and blue shirts, the dark colors. My hypothesis exactly is, "If you test how much UV radiation is attracted to pink, white, black, and blue shirts, then the darker colors, black and blue, will attract the most unlike the brighter colors." The independent variable in my project would be the four shirt colors and the dependent would be the UV ray level or LUX level.

To start out my experiment, I started with the pink shirt at noon, placed it on a table, set the UV meter on top with the range set to x100, and faced it directly towards the sun with the cap off. The shirt was set out for one hour exactly, charting the LUX level in intervals of 20 minutes. At 1:00 P.M, the same was done with the white shirt. This experiment was a two-day process and the second day consisted of the darker colors being tested. After the three LUX levels for each shirt were recorded in my data table, I calculated the averages.

With the proof of my data, my educated guess was proven correct. The white shirt definitely had less attraction from the UV radiation of the sun than the blue T-shirt, not as much the pink shirt.

The final conclusion of this project is that humans should wear bright colored clothing, mostly in the summer when the rays are the worst, to help protect themselves from skin cancer or wrinkles at an early age. This experiment was truly already applied to the real world because the UV rays of the sun can be very harmful to the skin.

Junior Division Energy

Shrey Rohilla

JR-ET-001

Battle of the Blades

The purpose of this project was to explore which vertical axis wind turbine (VAWT) blade generated electricity efficiently. I hypothesized that if the Savonius blade was used, then more electricity would be generated. This experiment involved testing three different VAWT blades (Savonius, Archimedes, Ugrinsky) and the control (HAWT blade). I measured the amount of electricity produced (volt) by a 5.5V DC electric generator using a digital multimeter.

The data collected did not support the original hypothesis. Based on the evidence, it is reasonable to conclude that the Ugrinsky blade generated the most amount of electricity. On average, the Ugrinsky blade had a 3.2% increase when compared to the Savonius blade, an 64.4% increase when compared to the Archimedes blade, and a 54.4% increase when compared to the control (HAWT blade).

Tavon Palmer

JR-ET-003

Alternative Energies: Good or Bad?

My hypothesis is that alternative energies are better not only for the environment but better for using (like houses, tools, cars, etc.). I will test this by seeing how much electricity both of these projects produce in one day. My hypothesis was right because there was no pollution in the experiment and it produced enough power to power a LED light bulb.

My statement of purpose is that I wanted to learn how much electricity each can produce. I also want to learn which one is better, gas or alternative energy. Well at the end of my experiment I found out that on a sunny day my solar panels can produce 24-25 volts, and on a windy day my windmills can produce 3 volts. But if there are clouds and no wind it will decline a lot.

First I got all of my materials that consisted of wires, a soldering gun, solar panels, balsa wood, windmill kit, and some electrical readers. Then I attached the solar panels to my house and soldered the wires together. I stuck it outside and read the electrical reader and recorded the data. Next, I put the windmill together and put a makeshift blade on and blew a fan (acting as wind) and blew somewhat windy and no wind. I wrote the data down and at the end I put all the data into this paper.

My results for my solar panels are dusk is 5.8 volts and mid/low light is around 15.6 and sunlight is 24-volt range (this was out of around 25 volts. And for my windmills I had, no wind is 0 volts somewhat windy is 1.5-2.5 volts and windy is 3 volts (this was out of 3 volts).

Peyton Rhodes

JR-ET-004

What's on Your Roof?

To better understand the cost and compatibility of solar panels, consumers can make an informed decision on how to purchase the most effective and cost-efficient solar panels. I created my own solar panels to test if it is more efficient to make my own, rather than paying the cost of a commercialized one. I created two different models: a model using blueberries as the main factor, and one using donut powder as the main factor. I compared the amount of energy each panel creates at nine AM, twelve PM, and four PM to an industry standard panel. I compared the data from each type of panel to see if it is more efficient to create your own rather than buying an industry standard one, thereby also being most cost-effective. My hypothesis was that the donut powder solar panels will create the most energy over seven hours of sunlight. The industry standard solar panels did store the most energy; however, the donut powder solar panels were competitive in terms of amount of energy stored coming in a relatively close second with the blueberry panels being least effective at storing energy. With more research in this area, it is possible to evolve the industry standard of solar panels to create something more cost-effective and equally efficient.

Wind Today, Green Tomorrow

Wind today, Green tomorrow is the experiment in which the difference between the shape and size of blades, the different speeds of a fan and leaf blower and lastly how much energy mini wind turbines can produce. To build the first wind turbine I put couplers and pvc pipe to build the post of it. Then I took the blades and motor I bought on amazon and put it in the opening of the pipe. I then put it in front of a fan on all the speeds and used a multimeter to see how much energy each speed produced. I then built the Thames and Kosmos wind power 2.0 kit that I purchased on amazon. For this, I just followed the instructions that came with it. I then also let it sit in front of a fan and see how much energy it produced. I then do the same thing with a leaf blower and measure the energy. The PVC pipe wind turbine ended up producing the highest energy with the box fan but did the worst with the leaf blower. I decided to do this research because it could potentially give you free energy if you had enough wind turbines and enough wind. In conclusion, The PVC wind turbine did the best when producing wind energy with the box fan and the Thames and Kosmos wind turbine did the best with the leaf blower.

Alternative Energy Production Using Thermite

The objective of this project was to be able to make renewable energy using Thermite. Thermite when in contact with fire, will get tremendously hot. In this experiment I tried to test just that. To do this I put sand on the bottom of a clay pot as a insulator, I then put water, Thermite, or water over the Thermite depending on each test. I then put a sparkler into the pot and lit it with the flame touching the Thermite causing the reaction. When the smoke cleared I checked the pots to see the result of each working and failing experiments to lead up to my final experiment. When I got to the final experiment I tried using a funnel which failed, burning and not containing everything. I decided to get a pipe and hold it in place with clay, the pipe holding water heated up, boiled and created steam spinning the turbine and producing electricity.

What I learned from the failed experiments is a proof of concept. I was able to produce electricity using Thermite, however it was only for a few seconds until I ran out of water to produce steam. A huge benefit is that the products are plentiful. There is 1 million tons of aluminum thrown away every year, and there is billion of tons of rust in scrap yards, and landfills. Therefore, I think that this could be a sustainable way to generate power. It is inexpensive, powerful, and clean.

Energy from Energy

The purpose of this project is to learn whether or not you can create energy from energy and if it is more efficient than an AC power source or a DC power source. I predict that the energy creating machine will not be efficient enough and that the AC power source will be more efficient. The AC power gave the battery 0.064 millivolts faster than the DC power gave the battery 0.039. The AC power source charged the battery faster than the DC source. The way the battery is charged. Dependent Variable: The millivolts the battery has gained.

Junior Division Engineering

Jesse James

JR-ENG-001

The Wright Wings

Being interested in pursuing a career in aeronautical engineering, I was inspired to learn more about how flight works. Through my research I discovered that the leading edge of an aircraft's wing splits the air over and under. The air going over the top is depressurized and the air pressure on the underside increases creating lift. In theory a larger wing with more surface area will create more lift increasing the distance an aircraft will fly.

Balsa wood, a lightweight building material, was used to create a fuselage and three wings differing in length. Each wing differed by one foot, starting at one foot. The wings were interchangeable with the same fuselage to minimize as many variables as possible. Once constructed and at the test site (the school gym where there would be no wind interference and another variable controlled) acting as the propelling force, I threw each wing three times, making sure to stand at the same starting location and extending my arm completely before releasing, and marked each landing spot at the furthest point of the aircraft.

With this testing the shortest wing length created the furthest average flight distance. Being that the wings contained different amounts of ribs and size, they all weighed different amounts and created differing amounts of drag. In the future it would be wise to use a consistent number of ribs to control another variable, although if you add more weight it would interfere with the lift to weight ratio used for flight.

Jonathen McCaslin

JR-ENG-002

Rocket Engine

A turbine engine connected to a combustion chamber made to withstand heat will not pollute air.

Brigid Morin

JR-ENG-003

Protect All

My project is an engineering project to design a prototype that protects light fixtures on my house from damage when I practice volleyball in my driveway. The design criteria were to create a prototype that is lightweight, portable, cannot be broken after multiple hits with the ball, and the protected object is not damaged with the equivalent force of a served volleyball. I set up this experiment by making a light model, with a plastic box and a glass piece. I used a basketball because the force of a basketball being dropped from 7 feet was very similar to a volleyball being hit by a teenager. I also modified the prototype three different ways and tested each modification three times each. My project passed each of the tests of the original design and the modifications. The only failure happened when we did something that was not a part of the base testing in which we dropped a weight greater than the prototype could stand (dropping 28.5 pounds). Even after that, the prototype itself did not break, but the glass model underneath did. I found that two layers of plastic and two-inch-thick foam worked best, but two layers of plastic with one-inch-thick foam worked as well. By only using one layer of the plastic and two-inch foam, the plastic box broke, but neither the glass nor the prototype did. The project met all design criteria and overperformed in the testing.

Watch It Wash!

We have all heard at least once during the COVID-19 Pandemic that we should wash our hands for 20 seconds. But how do we really know our hands are clean? The soap that I created changes color when one's hands are sufficient clean nine out of ten times, costs under \$6.00 to produce one bottle of soap, and it does not leave any undesirable side effects when used. I set out to create this soap by first shredding a white bar soap with a cheese grater. I then poured boiling water over the flaky soap in a bowl and stirred until the soap was dissolved. I let the soap sit for 24 hours until it thickened and then added thermochromic pigment. Thermochromic pigment changes color with heat and is what gives my soap its color change properties. My first prototype was successful to cost under \$6.00 to create one bottle of soap and it did not leave any undesirable side effects. However, it was only successfully changed color two out of ten times making it fail to successfully change color nine out of ten times. My design criteria were not met by my first prototype because the soap mixture I made had too much water and not enough thermochromic pigment. Because of this, not enough friction and body heat was created to activate the thermochromic pigment. In later prototypes, guar gum powder was added to thicken the mixture and more thermochromic pigment was added for more color definition. Washing your hands has become extremely important today and now there is an effortless way to know that our hands are free of germs.

Teagan Archer

JR-ENG-005

Alternative Hearing Aid

I created an alternative hearing aid. My engineering goals included, my prototype being under \$75, being Bluetooth, picking up sound from 15 feet away, having a portable power source, being 2 by 3 by 4 inches, and being able to amplify sound at the same rate. To do this I first created a case for my prototype. I then programmed a Raspberry Pi to input sound through a microphone and directly output it through a pair of Bluetooth earbuds. The Bluetooth earbuds did not work and after weeks of troubleshooting I finally settled on using wired earbuds. I tested it using a computer that played a video, and a decibel meter app. I did 5 tests with the prototype, and one test without. I found that when the computer was at 0 feet with the Raspberry Pi the volume was at 53.4 dB, whereas without the Raspberry Pi, it was at 50. Like I expected, there was a steady decline the farther back the noise got. This shows that the Raspberry Pi did act like a hearing aid, and amplified the sound slightly. With my engineering goals, it was under \$75, it was not Bluetooth, it did pickup sound from 15 feet away, at a normal conversation dB, it did have a portable power source, it was the correct size, and although I could not figure out a way to test if it amplified the sound at the same rate, from listening to it, I conclude it was close.

Liam Bois

JR-ENG-006

Not So Silent Sonar

In 2010, the number of blind individuals in the United States was 1.29 million people. The National Institute of Health estimated the number will be 2.17 million in 2030. The main tool of use for the blind is still the white walking cane introduced in the United States in 1930. There have been few advances to further aid people with blindness to help navigate their environment.

The foundation of this project was to help the blind navigate many areas using the principle of animal echolocation. It requires a microprocessor system board to process the data from a sonar when continuously probing the individual's environment. The developed program keeps track of the distance between the individual and obstacles. The system board is programmed with many subroutines to produce the functionality of the sonar. The sonar needs to be very well calibrated to produce real time distance data from sonar to the nearest obstacle.

The experimentation with the sonar showed very good correlation with expected measured distance. A subroutine was added to the program to provide an auditory signal to the individual. The chirp of the signal would increase in frequency as the object got closer. This collaboration between the sonar and the warning beeper can accurately help the blind person navigate its environment. The current limitation is that the sonar does not report obstacles more than 1.52 meters (5 feet) away or closer than 5 centimeters (~2 inches). The sonar also is inaccurate in the presence of sound absorbing materials.

Dust Begone: Using Arduinos to Clean Mars Rover Solar Panels

Mars rovers are critical in exploring the Red Planet, but their abilities and lifespans are impacted by dust buildup on their solar panels. The purpose of this project was to design, program, and test a device that can clean a Mars rover's solar panels from dust using three methods: a fan, vibration, and both. The machine was created using Arduinos, placed on a cardboard strip. The testing was done by placing the machine in a well-lit area outdoors, sprinkling ground black pepper (to simulate Martian dust) on the solar panel, and running the test methods to clean it. Among the three methods, vibration combined with 30 degrees of inclination worked best. Using a fan only worked at 30 degrees of tilt and may not be feasible on Mars, where the atmosphere is much thinner. These results are promising and support that vibration and inclination of Martian solar panels may help improve their lifespan. Because some uncontrolled factors may have impacted my results, additional experiments are needed to confirm them and to see if vibration and inclination are applicable on Mars.

Keane Hammond

JR-ENG-008

The Drowning Machine: The Danger of Low Head Dams

Low head dams, known as “drowning machines,” are dangerous because they can draw buoyant objects toward them. They kill up to fifty people in the United States yearly. The researcher developed a means of identifying when they are dangerous by measuring a hydraulic ratio to characterize a dangerous flow over a low head dam.

The ratio divides flow rate (cubic feet per second) by head height (feet) to characterize the type of flow over a low head dam. Head height was varied while keeping a constant flow rate of 0.16 ft³/second in a constructed flume. The most dangerous conditions were when the ratio was between 1.93 to 0.32 ft²/second. When placed at a zero ft. head height, the dam got swamped and made a wave train instead of a low head dam. It was observed that when the water was running at a 0.42 ft. (5-inch) head height the downstream hydraulic environment was the most dangerous. Finally, when placed at a 0.58 ft. (7-inch) head height the recirculating current was too weak so no dangerous water structure was formed.

This project can be applied in the real world and could help many cities and towns across the United States identify river areas of higher risk for low head dams. For commercial dams, proper signage could be posted to prevent swimming in dangerous areas. Additionally, as whitewater parks increase in popularity, the ratio could help detect when whitewater features present danger.

Benjamin Sundheim

JR-ENG-009

And the Band Played On: Masks and Instrument Sound Quality

Trying to prevent spreading COVID-19 is an important issue right now, and as a member of a band, I thought about how this affects my musical career. One solution for reducing the spread of COVID in bands is by putting cloth covers over the bells of wind instruments. I wanted to determine what materials would be the best, i.e. did not affect the sound quality of playing. My hypothesis was that cotton would cause the least sound distortion while still being an effective way to prevent the spread of COVID. I tested this by making bell covers out of cotton, polyester, a poly-cotton blend, silk, and plastic wrap. I then played a scale while using each of these materials, and sent recordings to several professional musicians for a ranking based on sound quality. I also used a tuner to see how the different covers affected the pitch of the notes. Using plastic wrap as a bell cover was ineffective, as it created such a tight seal that I was unable to play. The results for the sound quality test as judged by musicians rated that most thought the cotton best preserved sound quality, while the poly-cotton mix distorted sound the most. The tuner showed that most notes went slightly sharp with coverings, which could be an effect of the problem that playing with a mask takes more effort to force the air through an instrument. Cotton is the best material to use for its high effectiveness in mask studies, its generally high rank in the qualitative testing, and for having only a small effect on pitch as measured by the tuner.

Building a Guitar

My science fair project was to see if I could build a guitar from stuff I have at home or that is easily accessible. My hypothesis was that I could do so. I was able to make a guitar from home using things that I already had or are easy to get and it was functional. What I had at home was wood for the body, a bottle for the bridge, more wood and nuts and bolts for the pickup and screws for the strings. I got the plug and the strings from my old guitar that doesn't work anymore. Then I got the copper wire, wax, and the magnets from online. After assembling all these and hooking it to an amp it played sound but it wasn't very loud.

In conclusion I accept my hypothesis because my guitar was not elaborate but it was functional. The source of possible error in my project is not enough copper wire wrapped around the pickup which didn't make a strong enough electromagnetic coil. The electromagnetic coil is what picks up the vibration of the strings which sends that to the speaker to make sound. If I were to keep building guitars I would learn how to design a better body, make the pickup and its pieces connected to the body, I could learn how to wrap the wire around the pickup easier and better, and I could learn how to make the pickup smaller.

Jakoby Ross

JR-ENG-011

Gear Down for What!

The purpose of this experiment was to make an automatic transmission for a bike that shifted based on incline. The way I did this project was I gathered and printed needed materials then assembled and tested the model. The data showed that model 1 was successful in printing, assembly, and in shifting in 3 of the 5 gears. Model two is unknown in all three categories at this time. It is possible to design, print, and test a 3D printed model of an automatic transmission for a bike. As the project progresses, the second model will be printed and tested. An automatic bike transmission could help make mountain biking easier and safer for beginners or people with disabilities.

Isaac Mesich

JR-ENG-012

Balloon Powered Car

My project is Balloon Powered car. I chose this as my project because I am very interested in cars. I would like to give special thanks to my uncle who taught me everything he knew about cars. I would also like to give special thanks to Elon Musk for making a car that runs on something that is not ran by fossil fuels.

Jai'Lee Kever-Espinoza

JR-ENG-014

Recycle Capsule

This project researched the operational holes in the recycling process globally and how to create a simple device to make it easier for recycling companies to do their job.

Landon Sanders

JR-ENG-015

Project Solar Bench

In a short description of my project, I want to make a solar bench, that can be a hangout area outdoors. I gathered research about solar energy, and used my knowledge about dimensions, and came up with a plan of what to do. There will be four seats that are around a square platform. There is a pole in the middle, and on that pole, there will be 16 USB ports, where people can charge their devices.

Rosemaree Coughlin

JR-ENG-016

Solar Rooftops and Gardens

Using research from other examples across the world, this design combines the concept of rooftop gardens and solar power, to make a sustainable closed looped system.

Jonothan Bendixson

JR-ENG-017

Project Blue River

Project Blue River is an engineering design to help clean rivers upstream from oceans, to prevent pollution from reaching the ocean and improving wildlife health.

Aiden Riddell

JR-ENG-018

Rooftop Powers

This project analyzed three designs: solar tarps, umbrellas and adjustable solar panels and explains the process to choose to best device.

Nicholas Hernandez

JR-ENG-019

Recyclables Vending Machine

Based on research that found that there is little incentive to recycle, this is a design to promote recycling as an alternative economic driver for both people who recycle and for the recycling companies.

Colten Vannest

JR-ENG-020

Rolling Rivers

My research question is What shape of wave wedge makes the wave with the biggest height in inches. I thought that the shaper design of a wedge would produce the best wave. I built the river by screwing together three pieces of wood in a c shape and installing a tank with a valve. For testing I installed the shaper and let the water run through the river for five seconds and recorded the wave height for 30 seconds. The funnel average was: 1. Inch the wedge average was: 1 Inch the brick average was: 1.6. I concluded that the funnel made the tallest wave.

Rohan Mysore

JR-ENG-021

Structural Safety Monitor

This project takes voltage outputs from two wheatstone bridges in a structure, one wheatstone bridge monitors stress and the other monitors excess moisture. An arduino takes two separate voltage readings and plugs them into a python code. The python code makes a real time graph that monitors the voltage outputs of the two wheatstone bridges. The python also uses Machine Learning to determine if the values of the wheatstone bridges are ok or not.

John Butler

JR-ENG-022

Light It Up

I wanted to turn my lights on before I went into my room. Can I make voice activation lights in my room? My goal was to design a voice activated light system. To accomplish my goal, I put the Anave light controller together and made sure it turns on. Then got the needed software to run the lights. Then turn on the controller and connect the computer to the WiFi on the controller. Then select the WiFi and then type in the password. Then saved this information. Then the controller was ready to connect to my WiFi. Then used the Anavi demo site "demo.navi.technology" controller ID to make sure it works. There was a lot of troubleshooting involved in developing the method to connect the smart home device to the controller. I needed to be careful with testing the wires and electricity. Test all criteria and calculate the percentage of criteria met. After each trial calculate the percentage of criteria met until you get to 100%. I met 27.2% of the criteria to work for the lights. This project has had many difficulties. Some problems I had were country power sources so I could not plug them in and I had to find a power source of my own and the USB would not connect to the computer, and the sensors were not working. My next steps would be to work on programming and try the sensors.

Junior Division Environmental Sciences

Louis Calkin

JR-ENV-001

Extended Use of Oil Phylic Hydrophobic Sponges in Stormwater Remediation Prove Effective and Economical

After a meeting with two different companies, I gained information on the remediation practice of wastewater filtration. Both companies have high efficiency sponge filtration systems of 89% total efficiency that removes up to 99% of trash. Both companies' sponges remove dangerous bacteria like E. coli and hydrocarbons including used motor oil.

Last year I found that adding OPHP (Oil Phylic, Hydro Phobic) sponges to an oil grit separator unit (OGSU) drastically increased the effectiveness of the OGSU by removing 99 % of the used motor oil present in the storm water. I truly want to see my sponges in the real world, so I needed to see if they could be cost effective.

OPHP (Oil-phylic Hydrophobic) sponges will prove NON cost effective when grit is added to the mixture of used motor oil and water because the oil will act as a magnet to the grit clogging the sponge and thus preventing prolonged re-use. Will OPHP sponges remain 90% or greater in effectiveness when wrung out and tested a second time, following repeat exposure to oil, water and grit?

Without success, the OPHP sponges would not be financially feasible. Because my tests turned out effective, I will have a strong argument for retrofitting existing systems. I really want to preserve our natural resources and water quality.

Isabella Yoder

JR-ENV-002

Air Pollution Succulents

The specific problem is air pollution resulting in sickness and death. Cars, buses, trains, planes, factories, and more pollute the air. Also cutting down trees is reducing the amount of oxygen produced causing more pollution. According to Natural Geographic, 9 out of 10 people are affected by air pollution, which causes heart cancer and respiratory sickness. We need to reduce the amount of trash we burn and trees we chop down or more deaths will occur. Using plants that are easy to care for, like succulents, we can reduce the severity of this issue.

Cameron Wolkow

JR-ENV-003

The Effect of Mushrooms on Biodegradable Products and Plastics

When we throw out waste, it sits in a truck and is shipped to a landfill. The breakdown process produces greenhouse gasses, like methane. Methane is harmful because once it is released into the atmosphere, it traps the sun's UV rays and causes the earth to heat up. Some people take matters into their own hands by composting, an eco-friendly process that doesn't produce as much methane as landfills do. Also, you can use the nutrients to create a healthy garden. But the process can be awfully slow. To speed it up, some people add mycelium to their compost. Mycelium is thought to help compost because it has a special adaptation that produces an enzyme that can break down matter. In my experiment, I wanted to compare how well mycelium and compost break down biodegradables and plastics. I tested this using three separate bags, each of them containing a pre-weighed medical mask, latex glove, biodegradable cup and bowl, compostable straw, paper straw, coffee filter, and paper plate. Bag #1 contained these materials plus compost. Bag #2 contained these materials plus oyster mushroom spawn. And Bag #3 contained only these materials. This bag is the control group. After 7 months, I recollected the remaining materials and reweighed them to get a before and after weight. I also performed other tests, like how much weight they could hold without breaking and how far each could stretch without falling apart. I found that mycelium and compost performed equally well at degrading these materials.

No More Royal Oil

I ran an experiment to see the best method to clean an oil spill. The test contained a model of saltwater, a created oil spill, and multiple inexpensive sorbents to test. It seems that the Pine Shavings came out on top with an average of 96.66% of the oil being absorbed. With this new-found data we can now use this new economically friendly and effective way to clean up oil spills in the real ocean. Now we can help save sea animal lives.

Samuel Calkin

JR-ENV-005

Biosourced Flame Retardant Is a Viable Alternative to Toxic PFAS Retardant

Preserve fresh water and fish by proving the viability of a non-toxic, natural fire retardant that can replace fire retardants containing Toxic PFAS (poly/fluoro/alkyl substances)/ called 'forever chemical' that contaminate water, fish and cause cancer and other illness.

How much damage will fire cause to untreated cardboard and oil-soaked cardboard compared to cardboard and oil-soaked cardboard treated with bio-sourced flame retardant when exposed to a specific amount of flame over a given amount of time?

Organic material treated with non-toxic biosourced flame retardant will experience less damage compared to untreated organic material exposed to the same intensity of flame over the same period of time.

The results of my testing show that exploration being done to replace toxic PFAS's using salt, cornstarch, clay, cellulose and other organic materials is on the right track! Biosourced materials should be explored in the ongoing race to develop an effective and safe flame retardant and fire extinguisher.

Brady Simmons

JR-ENV-006

Metabolic Effects of Caffeine on Daphnia Magna

My project is the Metabolic Effects of Caffeine on daphnia magna. This project is continued from last year tested energy drinks. We diluted caffeine into the water. We tested it 5 times for each amount of caffeine. We looked under the microscope to count their heart rate per minute. The caffeine did not end up killing or increasing their heart rate. So, there must be a mother chemical inside the energy drinks that killed the daphnia magna.

Shreya Sethuramalingam

JR-ENV-007

Chlorophyta and Lemnoideae Components Impacting the Contaminants of H2O

What are the effects of Duckweed and Green Algae growth on water quality? I conducted an experiment, where Duckweed and Green Algae would grow in contaminated water consisting of chemicals in order to figure out how their presence impacts the pH, Chlorine, Ammonia, Nitrate, Phosphate, Total Dissolved Solids, and Electrical Conductivity levels, which are essential components that impact aquatic organisms. As I used water testing strips and meters to confirm the quality of the water every day, I acknowledged how there were drastic changes in the water quality due to the Duckweed and Green Algae growth. According to the average data, I concluded that the Duckweed improved the quality for the pH and Ammonia levels, while the Filamentous Green Algae improved the water quality in terms of Ammonia, Nitrate, and Phosphates, although the levels did not drastically change. Also, this experiment concluded that both Duckweed and Green Algae did not assist the water quality in terms of Total Dissolved Solids and Electrical Conductivity as the levels increased, while the Duckweed growth also negatively affected the Nitrate levels through a rapid increase. These trends in data contribute to the overall conclusion that Bioremediation plays a primary role in improving the water quality in ponds due to the potentials of Duckweed and Green Algae, which have the ability to produce a safe environment for aquatic organisms.

Would You Drink That?! The Relationship Between the Type of Batch Test and the Amount of PFAS Parts Per Trillion

What kind of filter (using different reverse ion resins and amounts of GAC) cleans the water of PFAS following the EPA's 'Environmental Protection Agency' and EWG's guidelines 'Environmental Working Group' of 70 parts per trillion? I hope to discover what amount of GAC and anion resin removes the PFAS from water, and if it follows the guidelines of the EPA's contaminated drinking water advisory. My independent variable is the type of batch test and the continents of the batch tests (GAC (granular activated carbon), anion resin, and reverse ion resin). My dependent variable is the amount of PFAS (PFASs, PFHxA, PFOA, PFBS, PFHxS, and PFOS) that is found in the water after filtration in parts per trillion. My hypothesis is that the batch test with anion resin and GAC (BT Number 1) will be more accurate than the batch test with reverse ion resin and GAC (BT Number 2) and the batch test with anion resin and reverse ion resin (BT Number 3). I believe that because ion exchange resins are like tiny powerful magnets that attract and hold the contaminated materials from passing through the water system. Negatively charged ions of PFAS are attracted to the positively charged anion resins. GAC is also one of the most studied treatments of PFAS removal, GAC is commonly used to absorb different compounds (such as PFAS). GAC is an effective adsorbent because it's highly porous, and it works better on longer chain PFAS such as PFOAs and PFOS. Since the water has PFASs, PFHxA, PFOA, PFBS, PFHxS, and PFOS in it I think that using GAC will be an important way to remove the PFOAs and PFOS since the anion resin is attracted to the PFASs, PFHxA, PFBS, and PFHxS.

My findings help people because of the critical issue that PFAS presents. PFAS are an extremely important and relevant issue, now with the novel coronavirus and just in general. PFAS are a toxic chemical that present a large problem that will need to be solved by science.

Knock Out! Bacterial Microflora as a Defense Against Tobacco Mosaic Virus in Phaseolus

An elaborate innate immune system protects plants against many harmful microbes, but it remains unclear whether this machinery alone is sufficient to protect plants against viruses.

To determine whether antibiotics impact viral infectivity, I inoculated multiple plants of *Phaseolus vulgaris* with a tobacco mosaic virus (TMV) at two concentrations of 0.1 mg/L and 0.01 mg/L. I watered or sprayed with broadband antibiotics, Kanamycin or Penicillin. I then classified the plants, following a procedure done by Katherine Wright (Plant Physiology 2018). After 5 days I evaluated the plants under a light microscope (100x) and classified them by levels of infection as stages 1-4. Stage 1 is light in color with the mesophyll intact and 4 being dark in color and necrotized. I then collected and averaged the data.

I conclude that when viral levels are very high as with 0.1 concentration of TMV infection the presence of favorable bacteria does not seem to benefit *Phaseolus vulgaris* plants, neither in its rhizosphere nor on the leaves. However, when the viral load is lessened, as with the 0.01 concentration of TMV, the *Phaseolus vulgaris* does appear to benefit from the advantageous bacteria both in its root system and leaves.

The Affects of Wildfires on Photosynthetic Rate

The purpose of this project was to investigate the effects of the smoke from wildfires on photosynthetic rate. The process of photosynthesis converts atmospheric carbon dioxide into glucose, through a series of complex chemical reactions which require light. The hypothesis was that the added particulate matter in smoke will serve as a filter, blocking light from reaching plants, thus causing a reduction in the rate of photosynthesis. Photosynthetic rate was measured using the chemical 2,6-dichlorophenol-indophenol (DPIP). DPIP is blue and turns clear as it is reduced during photosynthesis. The rate of photosynthesis was then measured by spectrophotometry. The photosynthetic rate of cells in a control environment (no smoke) was compared to the rate of those subjected to smoke-laden environments. The control data showed a steady increase in photosynthesis over the 15-minute testing time, with transmission increasing from 22% to 47%. The transmission readings for the chloroplasts in the light smoke environment also increased (from 18% to 34%), but significantly less, indicating a lower photosynthetic rate. The photosynthetic rate in the heavy smoke environment was very inconsistent, resulting in a net change of only 1% transmission. This data does support the hypothesis, indicating that smoke in the atmosphere can diminish photosynthesis.

Presley Wilson & William Wilson

JR-ENV-012

Wildfire Debris Mitigation and Feasibility for Use in Emergency Water Filtration Systems

The purpose of this project was to determine the feasibility of using charcoal debris from wildfires in an emergency water filtration kit. FEMA and the EPA encourage reusing and recycling debris from natural disasters. The Spring Creek wildfire (2018) burned 108,045 acres of mostly forest land. At a low estimate of 40 trees per acre, approximately 4.3M trees were burned.

Methods: 1. gather charcoal for processing, 2. activate charcoal, 3. design and make water filters, 4. test the water for quality, 5. design a prototype emergency water filtration kit. Four types of filters were used: (1) commercial PUR filter, (2) homemade charcoal, (3) salvaged charcoal, and (4) harvested charcoal. The controls were distilled water and tap water without filters. Filter (1) was tested with tap water. Filters (2), (3), and (4) were tested (activated and unactivated) with both distilled water and tap water to determine if the charcoal filters improved water quality or added contaminants.

Activated homemade and harvested charcoal both improved the quality of tap water. Further testing, using the CDC recommended disinfectant for emergency situations, showed that treating distilled water with a drop of bleach increased several testing levels; while the same water run through the activated harvested charcoal filter returned the levels back to those of the distilled control confirming that harvested charcoal from wildfires does have the potential to mitigate wildfire debris and decrease risk to human victims of hurricanes from contaminated drinking water. A prototype emergency water filtration kit was designed.

Fire Suppression Techniques

My topic is fire suppression techniques. I chose this topic because I was curious about all of the wildfires going on in our country, for example, in California and Colorado. The Hypothesis for this experiment is that if water and phosphorus are used to put out a fire then these techniques will put out a fire faster than using salt, dry ice, lid over fire, or the knockdown technique. Water is effective in putting out fires because it creates a barrier between oxygen and fuel sources like wood. Phosphorus is also effective in fire-fighting because it smothers the fuel.

For my experiment, I used chemicals, liquids, and techniques. For chemicals, I used phosphorus and salt. For liquids, I used water and dry ice, and for techniques, I used the lid over fire and knockdown technique. I lit the fire in a box. To start the fire, I used a fire starter, and I used the same length and amount of wood for each fire experiment. I let the fire burn for 5 seconds before attempting to put it out. For each chemical, I used 1 ounce to pour on the fire. In my experiment, water and phosphorus took 2 seconds to put out the fire, the knockdown technique extinguished the fire in 15 seconds, the lid over fire technique stopped the fire from burning in 17 seconds. Using one ounce of salt and dry ice was not enough of either substance to put out the fire.

In this experiment, I learned about different techniques that can put out a fire and which ones work the best. I also learned that there can be different types of fire extinguishers.

HABs and Algal Blooms

HABs are an issue that affects all aspects of life. These harmful algal blooms are a result of many man made issues, but one of the leading causes is nutrient pollution. The chemicals nitrogen and phosphorus are commonly found in fertilizers, when these chemicals leak into water sources, it fuels normal algal blooms, transforming them into HABs. This nutrient pollution also affects other aspects of the water and causes a multitude of issues. Nutrient pollution and HABs can destroy aqua habitats, limit sources of drinking water and lower consumption of an area by tourists, hurting the economy.

Oil Combustion

I chose to do my Science Fair project on oil combustion because I really like to learn about heat and fire. I chose burning two household vegetable oils- avocado oil and olive oil- and recorded time burned, smoke produced, and heat produced, to evaluate them as alternatives to burning fossil fuels. My hypothesis was that avocado oil would burn longer and hotter than olive oil. For this project I got $\frac{1}{4}$ of a paper towel and soaked it in each oil for 20 minutes. Then I started the oil- soaked paper on fire, set the timer, and took the temperature with an infrared thermometer. Avocado oil did burn longer and burn hotter than olive oil. I also observed and learned that olive oil has a lower smoke point than avocado oil because olive oil produced more visible smoke at a lower temperature. In conclusion, avocado oil has a higher smoke point than olive oil, and burns longer and hotter. My experiment supported my hypothesis.

Carbon Capture: Refining Process

I chose to do my Science Fair project on oil combustion because I really like to learn about heat and fire. I chose burning two household vegetable oils- avocado oil and olive oil- and recorded time burned, smoke produced, and heat produced, to evaluate them as alternatives to burning fossil fuels. My hypothesis was that avocado oil would burn longer and hotter than olive oil. For this project I got $\frac{1}{4}$ of a paper towel and soaked it in each oil for 20 minutes. Then I started the oil- soaked paper on fire, set the timer, and took the temperature with an infrared thermometer. Avocado oil did burn longer and burn hotter than olive oil. I also observed and learned that olive oil has a lower smoke point than avocado oil because olive oil produced more visible smoke at a lower temperature. In conclusion, avocado oil has a higher smoke point than olive oil, and burns longer and hotter. My experiment supported my hypothesis.

What Type of Soil Will Prevent Erosion from Happening?

My topic is erosion and I chose this topic because there was a flash flood right on my street in July of 2020. My hypothesis is: If samples of bare ground, ground with some plants and organic matter, and ground that is densely covered in plants are subjected to downpour-like conditions, then the sample with the most vegetation growing will have the least amount of erosion because the plants will slow down the water. My experiment is about erosion. I got 3 soil trays, then I got 3 different types of soil. They were regular soil, soil with little vegetation, and soil with lots of vegetation. In my experiment the regular soil eroded the most, then the soil with little vegetation eroded a little, and the soil with lots of vegetation did not erode. This tells me that lots of plants and grass can help prevent erosion.

Detection Carbon Monoxide

The purpose of my project was to learn and notify others of the amount of carbon monoxide in different everyday objects, like cigarettes, car exhaust, candles, and oven exhaust. I hypothesized that the car exhaust would have the most carbon monoxide because they have the biggest source of unburned fuel. My hypothesis was accepted, along with other surprisingly high results. The car was the highest amount of carbon monoxide followed by cigarettes, oven gas, and then candles. By the end of my project, I believed that ventilation is extremely helpful and there is more carbon monoxide around us than we think.

Sediment Movement

The purpose of this project was to determine if the angle of the bank of the river matters when taking away sediment. The experiment involved building a model river bed and controlled dispensing area. I collected sediment from the Colorado river to use in my experiment. Next, I laid 2060 grams of Colorado river sand on the river bed model. Each time I poured 5 gallons of water into a one-inch dip so the water would overflow onto the sand-covered river bed in an even stream and wash away the sand like a river would with the current flowing over it. Underneath the top of the model I selected different blocks of measured wood that corresponded with the angles of the river sections I was basing this off of.

I hypothesized that the test with the steepest river bed will have the most sediment taken away, and I was right. I was surprised to see that two of my angles had almost the same sediment taken away while the other had much more. Overall, I learned that rivers with steeper drops in the riverbeds have stronger moving water which takes away the most sediment. Conversely, lesser inclines in the river bed causes less sediment to move.

Single and Multi-Layer Water Filtering Apparatus with Commonly Available Materials

Gravity-assisted water filtering mechanism is explored using commonly available materials. A sample of raw lake water with particulates is filtered using these commonly available materials (sand, coffee filter, fabric, air filter) in a single layer and multi-layer set up and the resulting filtered water is tested using a commercially available water testing meter. The results are reported in Total Dissolved Solids (TDS) in parts per million (PPM). The reference water sample for the experiment is tap water. The results are tabulated and charted for various metrics obtained during the experiment.

Bottled Water vs. River Water

The purpose of this science fair project was to determine if it would be safe to drink river water in the case of an emergency situation. I hypothesized that the river water would come out cleaner than bottled water because it was not processed through a factory like bottle water would have been.

Throughout the experiment I used an equal amount of water between the two test subjects as well as using the exact same test. The variable in my experiment was the two different water samples. I measured my responding variable by using the Health Metric Water Testing Kit to discover all the chemical properties in the two separate samples of water.

The result of this experiment proves that river water is not nearly as clean as bottled water. The results show that my hypothesis was incorrect. The river water was the only one of the two that tested positive for bacteria.

If I were to conduct this experiment again in the future I would include a wide variety of types of water. I would also include more tests and test each water sample multiple times instead of just once.

How Do Oil Spills Affect Aquatic Plants?

No one can deny the devastating consequences of an oil spill on the local wildlife, either if it's plants, fish, and birds. This is becoming a global problem in each ocean, the factories working in the middle of the seas are already causing some oil spills to affect the ocean life and how they have avoided the oil so they are able to survive. How I tested to see if my hypothesis was correct is by filling each measuring cup with 300ML of water then in one measuring cup you put 10ML of oil the plant with the oil will start to die off because the plant wouldn't be able to survive due to the blockage of the photosynthesis. What the key points of the experiment was whether there is oil on top of the surface, the amount of water inside of the test tube, then the cardinal plant. The main problem that was in this experiment was whether there is oil on top of the surface that affects the plant in many ways. It would determine if the plant gets blocked from the sunlight it would cause the plant to die. From the data it shows that both of the plants with and without oil have an outcome of 13cm because the plant with oil started to slowly die off but the one without oil was healthy and oxygen was starting to develop. The conclusion I made from my science experiment was first they have the same amount of water inside of their test tube, one of the plants had a reaction inside of the test tube and the other had a reaction inside of their funnel. How I would apply this problem to the real world is if we stop admitting oils inside of the ocean poisoning different kinds of living plants, fish, and birds. This proves that oil is affecting aquatic life.

Junior Division Math & Computer Sciences

Niram Nagafuji & Akhil Ayalur

JR-MCS-001

Does Benford's Law Match COVID-19 Data?

We compared COVID-19 data from multiple data sources to Benford's Law to check the reliability of the data reported.

Logan Futrell

JR-MCS-004

The Probabilities of Diabetes: A Mathematical Study of Diabetes and Its Factors

The goal of this project was to find what factors affect the probability of someone getting diabetes including age, socioeconomics, ethnicity and gender. My procedure required me to use the internet to access the reports being used for data. I created a spreadsheet in google sheets to organize and store desired data from the reports. Then I found information about the different factors. I put the desired information into my google sheet to interpret data. Lastly, I used the trends from the data to create a diabetes risk calculator based off of the 4 factors. After analyzing the data, I found that the most probable age to get diabetes is from 45-64 years of age, the medium risk category is 65+, and the least common age is 18-44. The data also shows that poor states have higher percentages of diabetes and richer states have lower percentages of diabetes. I have also found that Hispanics have the most cases of diabetes, non-white/non-Hispanic have the second most chances of getting diabetes, and that white-non-Hispanics have the fewest chances of getting diabetes. Other than that, the data also shows that Men are more likely to get diabetes than women. This project was very interesting to me but if I did it again I would focus on one factor like socioeconomic and I would have many other variables like exercise, median household income, and what the average weight is for someone who lives there.

Alejandra Pena

JR-MCS-005

User Experience: Do Emotions Matter?

In this User Experience project, two animations were created to be viewed during experimentation. The first animation had vivid background colors, music, a cute jumping cat, large letters, and big shapes. The second animation had dark colors, small shapes, small letters, no music, and a crawling spider.

A testing plan was created to ask volunteer friends and family users to view the animations and answer questions about their experience when viewing the animations. The questions use a rating scale from easy to hard for being able to see specific shapes and being able to read a sentence in each animation.

Based on the data collected from survey answers, users enjoyed Animation #1 more than Animation #2. Through interviews and observation of facial expressions and body language, participants smiled and laughed while watching Animation #1. In contrast, participants leaned forward and squinted to view Animation #2.

In conclusion, the hypothesis was correct because the results showed how different users react positively or negatively while using technology. Users enjoyed watching an animation with positive content rather than one with no cheerfulness. One learning point was that the most effective design to use for animation is one that is pleasing and enjoyable for users. Users have their own preferences and should also be considered to make the best user-centered designs. This can be applied when creating solutions to help users solve their problems and have a positive experience.

Using Natural Language Processing to Analyze and Improve Communication Skills

In a time where many menial jobs are being automated away, the ability to communicate effectivity and efficiently is more important than ever before. While jobs that are easy to perform increasingly become replaced by machines, jobs that require the ability to communicate with others are essential and irreplaceable.

Using NLP or Natural Language Processing, computer programs have the ability to analyze and learn about natural, or human, languages. Using NLP, I created a Python program that can take in audio, video, or text, and compare it to a chosen role model speaker. From there, it can tell the user information about the ways each of them speaks. This includes polarity, subjectivity, vocabulary, frequency, words per minute, and more. Using this information, the user can learn how to emulate a role model they admire.

My program can be used to improve communication levels in people. Many individuals lack necessary communication skills such as public speaking, which my solution helps to remedy. My design provides an easy and accessible way for people in search of a way to improve their communication skills to do so.

Using Computer Vision Techniques to Count Jelly Beans

There are lots of objects that need to be counted in this world, such as a bunch of jelly beans. You want them to be counted correctly and efficiently, and without the errors or slowness that comes from humans. You also want it to be a simple process, something that is easy to use and does not need extensive equipment.

The key is something called Computer Vision. Using Python, I programmed a computer to recognize the number of objects in a photo. My code is able to use computer vision techniques to detect objects accurately and efficiently, and it's built all from scratch. My program loads a photo from a file, processes the pixels line by line, and then tells me the exact number of objects (I used jelly beans) in that photo. It uses strategies for handling complications such as shadows, reflections, and noise.

My program counts objects with speed and accuracy. It is so much more efficient than tedious human counting, and has so many possible applications in the real world. It only requires a computer, it has little to no errors, and it reduces the counting time from minutes to seconds.

Spin to Win

The goal of this project is to find the best place to put your fingers on a baseball to get the best side spin.

In this project I collected data from throwing a baseball with multiple throws for each finger position being studied. The data was collected using slow motion video capture and included the distance, quantity of half rotations and time. I used statistical analysis to review the data and determine which finger placement would result in the most rotations per second, while also considering speed and accuracy.

The data I collected showed that having your fingers non-symmetric to the axis of the ball, gave the ball more side spin. So you want to find a good middle point where you have good side spin, speed and accuracy. Based on my data having your pointer finger on the axis and your thumb far from the axis gave it ideal side spin.

Junior Division Medicine & Health

Julian Kramer

JR-MH-001

Don't UV Burning Me: A Comparative Study of Synthetic Versus Mineral Sunscreens

This scientific experiment, a comparative study, explored the question of which type of sunscreen blocks more ultraviolet (UV) rays. The hypothesis stated that if sunscreens with mineral and synthetic active ingredients are tested under the same conditions, then mineral sunscreens will block more UV rays than synthetic sunscreens because mineral sunscreens protect skin from sun damage by reflecting UV rays, contrary to synthetic sunscreens, which protect skin from sun damage by absorbing UV rays. Execution of the experiment involved application of each sunscreen onto a beaker watch glass, placed between a UV light above and a UV meter below. The data disproved the hypothesis because there was statistically little to no difference in the average UV penetration. The average UV penetration for synthetic SPF 30 sunscreens were 69.1 $\mu\text{W}/\text{cm}^2$, 67.3 $\mu\text{W}/\text{cm}^2$, and 67.5, and for mineral sunscreens 70.8 $\mu\text{W}/\text{cm}^2$, 114.1 $\mu\text{W}/\text{cm}^2$, and 114.9 $\mu\text{W}/\text{cm}^2$. The average of synthetic SPF 50 sunscreens were 43.9 $\mu\text{W}/\text{cm}^2$, 25.7 $\mu\text{W}/\text{cm}^2$, and 30.6 $\mu\text{W}/\text{cm}^2$, and for mineral sunscreens 27.3 $\mu\text{W}/\text{cm}^2$, 21.3 $\mu\text{W}/\text{cm}^2$, and 40.1 $\mu\text{W}/\text{cm}^2$. The averages of synthetic SPF 70 sunscreens were 20.5 $\mu\text{W}/\text{cm}^2$, 17.5 $\mu\text{W}/\text{cm}^2$, and 12.9 $\mu\text{W}/\text{cm}^2$, and for mineral sunscreens 8.8 $\mu\text{W}/\text{cm}^2$ and 11.8 $\mu\text{W}/\text{cm}^2$. Because skin cancer is the most common cancer in the United States with 3.5 million people diagnosed annually and with so many sunscreen products on the market today, this scientific experiment aimed to gain knowledge about the effectiveness of the two primary types of active ingredients in sunscreens, to help consumers make more educated decisions.

Mila Vigil

JR-MH-002

Brain Waves and Parkinson's Disease: An Early Detection?

Parkinson's Disease is a complicated topic. With many suspected causes, yet no recognized cure, this chronic illness stays confusing. Although the desperation to find a cure is valid, many doctors can agree that a fastidious detection can aid in slowing the progression. In this project, it examines how we can timely detect Parkinson's Disease and how heredity can be a strong factor in the discovery for the cure. Parkinson's Disease has no distinct cause or cure, yet one potential cause is heredity, the idea of genetic succession. Throughout this project, it examines the correlation of the brain waves of Parkinson's Disease patients, their relatives, and a control group (People who are completely unaffiliated with the disease), which can help define heredity. This project uses an electroencephalogram (E.E.G.) to record brain waves and compare them, where subjects are asked two complex questions. The more distant the relative group data is from the control group data, the more prominent the similarity is between the brain waves of Parkinson's patients and their family members. Throughout the experiment, it can be determined that there is correlation between the Parkinson's Disease patients and their relatives, which shows patterns of how Parkinson's Disease can be hereditary, and how we can use technology to detect Parkinson's Disease. Yet we also have to wonder what else could have caused this data to correlate, and although the claim of heredity is often negated, maybe this data points into a different direction, into the world of unknown exploration.

Lorin Koch

JR-MH-003

Stained It!

People are always wondering if the liquids they drink can stain and or color their teeth. This question was what started my scientific research. Which everyday drink really stains your teeth the worst? This project looks at the staining ability on your teeth of Dr. Pepper, Dunkin Donuts coffee with hazelnut creamer, and Sparkling Ice—naturally flavored blackberry water. The drinks were tested in a container with an egg placed in each. At the end of five days, the eggs were removed, allowed to dry overnight, and the brushed with a toothbrush and toothpaste for 2 minutes. Pictures were taken between four and five o'clock each night, with final pictures being taken after the eggs were brushed. My hypothesis was that Dr. Pepper would stain your teeth the worst. The experimental results showed that my hypothesis was false. Dr. Pepper cleaned up the most, with the coffee and creamer stained the egg the most, and the ice drink coming in a close second.

The Valiant Mask to Vanquish the Virus

The purpose of this project was to see what material of mask works better. As you know during this whole pandemic mask were and still are needed. They were needed to keep germs out there for some materials of masks were bound to work better than others. When doing this project, I found out that the N95 masks work better than cotton and polyester. My approach for investigating the problem was by visually looking at the talc fall. I concluded that the 95 masks work better than the cotton or polyester masks. In conclusion I met my objectives and the project I did will help people with their health.

To Sanitize or Not to Sanitize

The purpose of this project was to test if sanitizing our school tables is as effective as we all think it is. I hypothesized that by leaving the tables unsanitized it would encourage the growth of mod more than it would with a sanitized table.

This experiment involved taking three different fruits and rubbing them on our school tables, one sanitized and one unsanitized, and then swabbing the tables and seeing how much mold growth has shown after three days.

The data collected did support the hypothesis. The findings from the experiment lead to the conclusions that sanitizing our tables does help slow the growth of bacteria. It did however also show that sanitation is not a full-proof way of getting rid of bacteria.

The Mightiest Mask?

Masks, what were once used on the night of October 31 to create a false identity, and that were only used in hospitals as a piece of protective equipment, are now an essential precaution against COVID-19. My hypothesis began with wondering what mask would protect people the most, from deadly bacteria. Collecting the masks and using a spray bottle to represent a sneeze, I sprayed the mask with a red gelatin dish called an agar dish to catch what passed through. After incubating the bacteria ridden Jell-O, the results were ready to be evaluated. The experiment proved my hypothesis incorrect. Instead of the surgical mask performing the best as I hypothesized, the N-95 mask prevented the most bacteria from slipping through.

Are Those Expensive Toothbrushes Worth It?

The purpose of this science fair project was to determine what toothbrushes clean teeth the best. The cost of toothbrushes can vary greatly. Some cost only a few dollars, while others cost hundreds of dollars. The toothbrushes used in this project were a Waterpik sonic fusion, Burst, and just a manual toothbrush. I hypothesized the Waterpik sonic fusion toothbrush would clean the best debri from teeth more efficiently because of the way it vibrates. To measure the cleaning ability of each toothbrush, a washable paint was used on wax paper and brushed with four brush strokes. The amount of paint removed was measured in order to determine the effectiveness of each brush. In all three trials the manual toothbrush removed the most paint, the WaterPik Sonic fusion second, and Burst third when compared to the control. The hypothesis was that the WaterPik Sonic Fusion toothbrush would do the best. In conclusion the hypothesis was rejected because the manual toothbrush cleaned better than the WaterPik Sonic Fusion toothbrush and the Burst toothbrush. One reason that the manual toothbrush did the best is because it had stronger bristles and a bigger head than the others. Also, the WaterPik Sonic Fusion didn't do great because it has a head that shoots water. Unfortunately, this project was unable to use the water feature because using washable paint as the means of testing. In the future I would like to test the toothbrushes on real teeth.

Are Masks Really Good for Your Health?

The reason for doing this project is due to COVID-19 and all of the masks we wear. We all have to wear masks at some point. One day I asked myself, are masks really healthy for us?

I hypothesized that wearing the mask would not affect your oxygen level because my research shows that you have to have some sort of respiratory illness in order for it to affect your oxygen level.

I talked to my qualified scientist about ways to measure your pulse oxygen level. She explained how you can use a pulse oximeter or an arterial blood gas (ABG) which is more accurate but it is very painful and it is hard to run on a treadmill with it on (Paulson, 2020).

My tests showed that the oxygen level did not change that much. When at rest it stayed between 97 and 99. When I was exercising it stayed between 96 and 97. My oxygen level did not change tremendously.

The project has contributed to my interest in finding out if masks are unhealthy for students who wear them for 6-8 hours per day. Also, my results may impact people's decisions who do not want to wear masks because they worry about health risks related to mask wearing.

Study of the Efficiency of Different Face Masks in Preventing and Controlling Transmission of Communicable Diseases Like COVID-19

Communicable diseases like Covid-19 can spread when an infected person sneezes or coughs while in close contact with other people. Face masks help prevent and control transmission. When the Covid-19 global pandemic started, there was a face mask shortage. People started using disposable or home-made face masks. This project studies the efficiency of the different kinds of commonly used face masks.

A simple setup was created using recyclable and easily available materials. A spray gun was used to spray colored water onto masks, made out of different fabrics. The masks tested were a 2-layer quilting cotton homemade mask, 1 layer quilting cotton homemade mask, 2 layer knit cotton homemade mask, 1 layer knit cotton homemade mask, polyester neck gaiter, 2 layer lightweight woven cotton bandana, 1 layer lightweight woven cotton bandana and a disposable mask. The spray patterns were compared based on their droplet spread area. The experiment was repeated with fluorescent water and the spray patterns observed with a UV light. All the single layered masks let a lot of droplets pass through. The 2 layered quilting cotton mask was a clear winner. The disposable mask was the second best choice.

After analyzing the droplet spread area of the spray patterns in both trials, it was determined that the 2-layer quilting cotton mask is the most efficient. The 2-layer quilting cotton mask is the best choice to prevent transmission of droplets and also protect from spread of diseases.

The Most Effective Liquid Antacids

The purpose of this project was to see what the most effective liquid antacid was out of three different liquid antacids. My hypothesis was that out of Pepto Bismol, Mylanta, and Gaviscon liquid antacids, then the Pepto Bismol would be the most effective because it coats the lining of your digestive tract.

I tested my hypothesis by adding drops of a liquid antacid into a solution which contained grape juice and lemon juice. Lemon juice is an acid and grape juice is a natural acid indicator, so it changes colors if the acid is neutralized. In test tubes I added 10 drops of lemon juice and 10 drops of grape juice and added drops of the different antacids until the solution changed color. Once it changed color I recorded the amount of drops it took and wrote the data in a table.

The results of this experiment proved my hypothesis to be incorrect. The most effective liquid antacid was actually the Gaviscon which took only an average of 11 drops to neutralize the acid. The Pepto Bismol was actually the least effective and took an average of 28.33 drops to neutralize the acid. The Mylanta took an average of 13 drops.

Some conclusions I made from this experiment was that the Gaviscon and Mylanta have close numbers for how many drops it took to neutralize the acid. The Pepto Bismol barely even mixed with the solution so there wasn't even that much of a change in color. If I were to conduct this experiment again or expand on it I would try more of a selection of antacids, to see which one truly is the most effective.

Marshmallows: Do Healthier Alternatives to Corn Syrup Impact Taste and Texture?

There are many people today such as my mom who are always searching for healthier alternatives to the sweets and foods we eat. I also have a sweet tooth and so I researched healthier ways to make marshmallows using higher quality ingredients other than corn syrup because studies show corn syrup has been linked to health problems such as obesity, type-2 diabetes, and increased liver fat, which can lead to serious health risks.

I believed that there would be no substitute for corn syrup as corn syrup is the primary ingredient in most store-bought marshmallows. As it turns out, I was wrong. I made one batch of each type using maple syrup, corn syrup, and honey. Then, when we tested the texture (as you can see in my results) the maple syrup marshmallows were way too sweet, they were brown in color and the texture was just terrible. The corn syrup batch turned out just like typical store-bought marshmallows, and surprisingly, the honey was amazing! They were bright white, had an amazing fluffy texture, and tasted even better than the regular, store-bought marshmallows with corn syrup!

Lip Balm Testing: Is the Ratio of Ingredients a Factor in Quality?

Will the ratio of ingredients when making lip balm affect how well the lip balm works? Four recipes were created with different amounts of beeswax, almond oil, and shea butter. Five tests were performed. First, the water seal, which prevents the moisture in the skin from evaporating, was tested. The second test examined which lip balm held the best under hot conditions. The third test determined how well the lip balm stuck at different temperatures. Test four calculated how many rubs were needed to get complete coverage, which helped to determine the yield at room temperature. Finally, customer preference was tested. Each test was performed three times and results were recorded in tables.

Recipe B and D created the best water seal. The more beeswax in a recipe, the higher the melting point. Test three and test four were not as accurate tests because they required some amount of pressure, and it was hard to ensure that the same amount of pressure was used each time. The recipes all had similar yields except for recipe D, which was so soft it couldn't be tested. The results for test five were not as accurate due to COVID-19 because there were three participants instead of ten. Each customer chose a different recipe, so there was no overall preference. The ratio of ingredients does affect how well the lip balm works.

Blink-183 – The Effect of Projected versus Reflected Light on Blinking Rate

Given our current life circumstances, eye strain is a prevalent issue that we face on a daily basis. Many people spend time on projected light sources, which will increase eye dryness, fatigue and irritation. Light from a projected light source is different from light from a reflected light source. In this experiment, participants will read the same document from a personal computer and a piece of paper. I will be measuring the blink rate per minute from the participants to identify if projected light will cause one to blink less per minute. What I will learn from this study should provide general benefits to future research on eye strain connected to device usage.

The hypothesis for this experiment compared the two sources of light, in addition to the control phase which involved casual discussion. If a participant read the same document from both a reflected light source and a projected light source and blinking rates were compared, projected light would cause the participant to blink less. This is due to the stronger light source causing a reader to focus on the task at hand and be more attentive.

Blinking rates while reading from both light sources were shown to be less than the control. The subjects' blink rate per minute decreased while reading the document from the projected light source. The participants blinked about 30% less when they read from the document on their computer. These results confirmed my hypothesis.

The usage of devices with projected light screens is now common due to many current social and health factors. The prevalence of these devices could be detrimental to eye health because of the results of this project.

Junior Division Microbiology & Molecular Biology

Aubrey Holmes

JR-MMB-001

Antibiotic Post Mortem: Take Two

People in other countries might not have access to unexpired penicillin. This experiment measures the efficacy of expired frozen and expired heated penicillin. The results indicate expired penicillin is most effective when stored at room temperature and least effective when heated. The efficacy of expired penicillin decreases as the temperature increases. Frozen expired penicillin is more effective at killing staphylococcus aureus than heated expired penicillin. Medical professionals should take precautions against heat when sending penicillin to other countries with limited access to antibiotics.

Armaan Gill

JR-MMB-002

Transformations of E. coli with Plasmid DNA, Calcium Chloride, Ampicillin and Arabinose Sugar

This year my science fair project was about bacterial transformations. Its purpose was to see how nutrient agar containing ampicillin would affect the amount of successful transformations. These transformations were conducted on ampicillin plates, and compared against transformations on plain Luria Broth plates. This project will help determine how effective ampicillin is in helping break down cell membranes and if transformations have to be conducted using ampicillin plates. I hypothesized that the ampicillin plates would have a major effect on the number of transformations. I thought this because multiple studies have already shown that ampicillin does affect the amount of successful transformations. In my procedure I would take 500 microliters of cold calcium chloride and put 250 μ L in a plus plasmid tube. I would then put the remaining calcium chloride in a minus plasmid tube. After this I would put 2-5 mm of E. coli colonies into each tube, then I would add two loopfuls of plasmid DNA into the + plasmid tube. After letting these tubes sit on ice for 15 minutes, I would heat shock the tubes in a 42 degrees Celsius water bath. Next, I pipetted 100 microliters from each tube and would spread it onto the corresponding petri dishes which all contained arabinose sugar. I found that the ampicillin plates containing arabinose sugar provided the highest amount of transformations. This happened because the ampicillin killed any E. coli that did not uptake the plasmid. This proves that bacterial transformations should be conducted on ampicillin plates.

Chloe Lubbers

JR-MMB-004

Bad Breath Bacteria

Farm workers and farm families are always in contact with their animals. Those people could be in contact with their health, and food. The results of this experiment clearly show which animal has the cleanest mouth, and which animal has the dirtiest mouth. These results will help farmers and vets who don't know whose mouth is the cleanest. My hypothesis was that the dog has the cleanest mouth. I swabbed the animal's mouth three times. With the swab I gently rolled it in the agar in the petri dish. After that, I waited three weeks for my bacteria to grow. The results of these experiments were that the dog has the cleanest mouth. This experiment was to help others who have animals with mouth problems, or dental issues.

Junior Division Physics

Lucas Dunn

JR-PH-001

On Target

My project was about testing shot patterns of different Waterfowl and Upland bird hunting brands of shotgun shells. My hypothesis stated that HEVI-Shot would have the densest shot pattern compared to Remington, Winchester, and Kent Cartridge brands. I tested four brands of shotgun shells, three times at two different distances (25 and 50 yards). I was able to set up my experiment at a gun range establishing distance at 25 and 50-yards and then firing at a 12-inch target with a 12-gauge shotgun. I repeated this process for each brand and distance and recorded the density each shotgun shell administered (counting the number of pellets inside each target). I found that the patterns varied for each brand and at each distance. My hypothesis was not correct because Remington brand had the best density pattern. I learned that testing these brands at two different distances was key to being sure the experiment was accurate based on the data I recorded. When firing at different distances and comparing the data it showed that my shots were accurate and I was truly testing only the density pattern and not my aim.

Rut Trujillo-Abeyta

JR-PH-002

How Is Water Attracted to Static Electricity

This project is very interesting to me because of the way a magnetic force, made by static electricity can control the way water flows. Because in water's liquid form, the hydrogen and oxygen atoms are able to move around, a static electrical charge can easily affect the bending of water.

The purpose of this investigation is to understand the function between energy and water molecules moving and staying still. If the water changes between solid and liquid form, then the static electricity, from the comb, will bend the running water more than the solid water.

The balloon had the biggest impact on the running water, the comb had the second biggest impact, and the rubber gloves had no impact on the running water. The comb had the biggest impact on the ice cube, the balloon had the second biggest impact and the rubber gloves had no impact on the ice cube.

My hypothesis was partially correct, because the ice had a more significant impact, but it turned out that the balloon had a greater significant impact on the water. The balloon had a significant attraction to the running water and the comb had the biggest attraction to the ice, but the rubber gloves had no attraction to the water nor the ice. If I did this experiment again, something I would do differently is try and compare different kinds of waters. This project is beneficial to the real world because it can teach people the kind of electrons water carries and also how static electricity, though it may not be the strongest form of electricity, can control water's molecules.

Jayli Lockhart

JR-PH-004

Which Will It Be: Floating or Sinking Soda?

In this experiment, I planned to find out which type of pop will float or sink. This helps people know which type of pop is good if they don't want a dense pop. The hypothesis of this experiment is supported by the results given. For this experiment, I put pop in different types of water. The regular pop sank which says that it has a lot of density. The diet pop floated which says that it doesn't have a lot of density.

The Science of Spin: Mass and Inertia

Mass is a measure of how much matter is in an object and inertia causes an object to resist changes in motion. For spinning objects, how the mass is arranged in the object affects its inertia which then affects the way it spins. Changing where the mass in an object is located makes it spin differently. The goal of this experiment was to figure out whether inertia can be measured at home using everyday objects.

A torsional pendulum is a special type of pendulum that rotates back and forth instead of swinging. This kind of pendulum can be used to measure inertia. Twisting the pendulum causes it to rotate, and the period of rotation is affected by its inertia. By attaching clamps to the pendulum in different locations, the inertia was changed and different values of inertia were tested. The period of the pendulum was recorded for each mass location, and the squared relationship between the period and inertia was shown to be true. The measured inertia was within +/- 13% to 16% of estimated values for the pendulum. This shows that inertia can be measured accurately using everyday materials at home.

Stretch It!

When my brother and I got a piano, we both noticed something about it. On some days, its pitch fluctuated. I also realized that the days the pitch fluctuated were relatively hot or cold! I knew this had happened to both me and my friends, so, I decided to learn more about this phenomenon by testing the effects of temperature on the pitches of different materials!

Friction: Does Material Matter?

The topic I chose was friction because I've seen a student do a similar experiment at a science fair and I thought it was interesting. It made me think about easy things in my life like the wax on the bottom of my skis and how I slide on tile and wood floors rather than carpet. My hypothesis was that if I set up my experiment to test a marble going down chutes covered with different materials all the same angle, going the same distance, that a marble traveling on steel would go fastest. I tested how fast a marble would roll down plastic wrap, wax paper, sand paper, aluminum foil, steel, burlap and cardboard, each with different friction. My hypothesis was incorrect. The marble traveling down the plastic wrap was fastest. I did 10 tests for each material taking averages. All surfaces were pretty close in marble speed so I had to calculate milliseconds, not seconds. The steel chute was a different shape but might've been faster if it had been smooth instead of a V. Doing the experiment required me to be consistent, careful, and exact in my measurements. I was surprised that the fine grit sandpaper was the 3rd fastest but a rougher sandpaper would have had bigger particles which might have made the sandpaper slower. I learned that using steel doesn't make it the fastest. The chute's shape could have mattered and the roughness of the steel could have affected the marble's speed.

The Rainbow

This science fair project was about rainbows and how they are made. For this experiment my hypothesis was: At different times of the day you will see less colors of the rainbow appearing on the blank note card after the sunlight reflects off of a mirror. In my experiment I used a baking pan and filled it with about an inch of water Then I set the pan by a window where there was direct sunlight. On the inside of the pan there was a mirror. The mirror would reflect the sunlight through the water onto the card. After I did this I figured out that my hypothesis was correct, there were less colors at different times of the day. With the data I collected, I figured out that when the sun goes down further, more colors become visible while earlier in the day less colors were visible. The colors were most visible at four o'clock pm. and were least visible at twelve o'clock pm. This data helps me better understand when rainbows are most likely to be seen.

Sophia Dainty-Guilfoyle

JR-PH-010

Does a Softball Go Further Than a Baseball Being Pitched by a Pitching Machine?

I think that the softball will go further because it is bigger and has more mass, so it will spin slower and not use as much energy to move and go further. It will not go faster because it will go further.

I started off doing the softball in the pitching machine on the speed 4/10 and tested that 10 times (measuring and timing each time). Then I did that on 6/10 and 8/10. I did the same thing for the baseball, and averaged out the times and distances.

The softball went further than the softball by a lot. For the 4/10, the softball average was 144.5 inches and the baseball average was 125 inches. For the 6/10 average for softball was 411 inches and the baseball was 270.8 inches. For the 8/10 the average for the softball 813.2 and the baseball was 482.9 inches. The softball went further than the baseball in all of the tests and was slower than the baseball in all of the tests.

Tegan Mestas

JR-PH-011

What Bat Has the Most Speed Off the Bat?

Which bat has the most speed off the barrel. My hypothesis is the aluminum bat will do the best. You get three bats you need then take 5 hits with all of them you use a radar gun to catch the speed. The composite bat had the most speed off the barrel. The composite bat is the best for speed in a game.

Andrew Simmons

JR-PH-012

Rifle Accuracy

My research question is which gun is most accurate for a certain range? My hypothesis is that the 30-06 will be the best gun for the 100-yard range. The 22-250 will be the best gun for the 75-yard range. The 30-30 will be the best gun for the 50-yard range. First, I will set up the table and the stand then I will shoot all four guns and after that I will measure how far away I was from the bullseye. The 20-250 was the most accurate for the 100 yd range. The 243 was the most accurate for the 75 yd range. And the 22-250 was the most accurate for the 50 yd range.

Colt Rapier

JR-PH-013

Physics of Hitting a Baseball

My project is about using physics with hitting baseball. My hypothesis was that with a 40 degree angle and a full body swing the ball. My procedure was to use a contraption that me and my dad built to get the proper angle to get the needed angle than we tested wrist swing, elbow swing, shoulder swing, and full body swing and then test a 20, 30 and 40 degree angle. My results were that with the swing of the full body and 40 degrees the ball went the furthest in paces and in feet. My conclusion is that my hypothesis was incorrect and correct it was 40 degrees and a full body swing.

Braelinn Penaflor

JR-PH-014

Hot vs. Cold

Playing softball is a fun and competitive sport. One important skill of the game is being able to hit the ball, and the farther you can hit it, the better off you are. Teams play in all types of weather, hot or cold. This experiment was able to determine how temperature affects the distance a softball will travel after being struck by an aluminum bat. The hypothesis was that the cold ball would go further because of the impact and could possibly go further than the hot. This experiment would help softball players including me have a better understanding of why my softball hits wouldn't go as far in certain types of weather. The problem this experiment solved was that the hot softball core made the softball go further because of the impact. My approach for investing was that there was the same type of softball bat and types of balls and hitting at the same exact spot each time. This experiment obtains that the hot softball core went further than the cold by the averages of 144.8444444 for hot and 130.7555556 for cold.

Heat Wave

Have you ever wondered if you could change how much money your bill is for heating and cooling your home? Well you can. This experiment determines which window covering worked better to keep out warm and cold air. I tested this by building a small house with a window and placing a thermometer inside the house. I used blinds, tinting and curtains to cover the window. A heat lamp was placed outside the house to shine in the window. My hypothesis was that the window tint was going to work the best. I tested each window covering 5 times and averaged the results. The blinds worked the best out of the three window coverings. My hypothesis was wrong. I didn't consider that window tinting I used was for cars and not temperature control.

Mini Wind Tunnel

I am interested in Formula 1 racing, and the cars have intricate designs to make the car faster on the racetrack. I found out that these components were tested with a wind tunnel, and so I built a wind tunnel to test the performance of those components.

The Mini Wind Tunnel is powered with a fan that can run at about 4000 RPM, and a diffuser made of straws on the opposite side of the fan. In the testing area of the wind tunnel, there is a weighing scale used to measure the downforce or lift that the test object is generating.

Depending on the vehicle, the aerodynamic configuration will definitely change, and many tests have to be run. There were certain refinements like a widened surface area, and material changes that affected how the air interacted with the front wings. Of my test objects, a widened styrofoam wing, and a widened cardboard wing fared the best in terms of downforce. As we strive for more efficient transportation, aerodynamics will play a very important role in improving efficiency, and speed of many different vehicles.

How to See Ionizing Radiation in a Cloud Chamber

The everyday person is surrounded by natural radiation daily, yet it is invisible to the bare human eye. The project focuses on making this radiation visible from different objects using a cloud chamber to produce visible tracks. Bananas, Brazil nuts, a Thorium Welding Rod, and orange Fiesta ware will be tested inside the cloud chamber with the expected outcome that the objects containing more radioactive components would emit more supercharged particles, which would cause more visible rays. An example of this hypothesis is the Thorium Welding Rod because it has the radioactive element Thorium, which could produce a large number of supercharged particles that would become visible in the cloud chamber. The cloud chamber was built using a black tray, dry ice, an insulated container, and a plastic container containing isopropyl soaked sponge. The Independent variable being tested was the object placed inside the cloud chamber, the Dependent variable was the amount of visible rays produced, and the Controlled variable was the amount of ice and alcohol used.

Yeti vs. Pelican vs. Orca

The purpose of this project was to test which top brand cooler held ice the best. I hypothesized that the Yeti cooler would stay the coolest.

This experiment involved placing a Yeti, Pelican, and Orca cooler in a garage that was kept at 70 degrees Fahrenheit. I had to put 7 lbs. of ice in the Yeti cooler (35 quarts,) and 8lbs of ice in the Orca and Pelican coolers (45 quarts,) because Yeti doesn't make 45 quart coolers. I then went to the garage and checked the temperature of the ice, inside, and outside wall of each cooler at 2:00 p.m. every day for a week.

The data I collected did support my hypothesis. On average, the temperature of the Yeti cooler stayed the coldest. While, the Pelican fell right behind the Yeti at staying the second coldest, and the Orca cooler in last place.

These findings lead me to conclude that the Yeti cooler would be best for holding ice the best. To learn how the coolers would hold the cold in different temperatures, more testing would need to be done.

Inflight Balance

The whole idea of this project was to test how the distribution of weight affects the flight of a projectile, it hypothesized that if three differently weighted projectiles were launched, the projectile with the weight in the center will fly the farthest. The thing that was changing throughout the experiment was the area that each projectile was weighted (front, middle, back). According to that, the projectile will be launched a certain distance (the dependent variable), along with that, the strength with which each projectile is launched will stay the same throughout the experiment. After each projectile was launched the distance between the front of the launching device and the far end of the projectile was measured and put into a data table. In the end, the mid weighted projectile was launched the farthest distances with an average of 92 inches, proving the hypothesis correct.

Stretching the Jacob's Ladder

This project was based on Jacob's ladder. I wanted to see which metal would be able to create a spark that can travel the highest up the rods, and create the most sparks in 20 seconds. I will be testing with steel, stainless steel, and aluminum. I hypothesized that the stainless steel would do the best, followed by steel, and then aluminum. The experiment involved building a Jacob's ladder. I needed to build a safe, effective Jacob's ladder, and design a process that was easy to test with. I would secure my rods at the needed distance and, each time make sure everything and everyone was away from the device. I would then turn on the transformer, record my results, and turn off and unplug the circuit. I would continue these steps until I was finished gathering data. In the end, I found out that with a max distance of 1" in between the bottom of the rods, the steel did the best. Next came aluminum and stainless with both a max base distance of $\frac{3}{4}$ ". The only thing that set the aluminum in front was the height the spark traveled up the rods and the amount of sparks produced. In the end, this proved my hypothesis wrong. I thought that the stainless steel would do the best, but it actually did the worst. The steel came in first, and the aluminum in second. Next time, I would be interested in trying copper, too.

Junior Division Plant Sciences

Kanshita Dam

JR-PS-001

How Do Vibrations from Sounds Waves Affect Plant Growth?

The purpose of this experiment was to answer this question: how do vibrations from sound waves affect plant growth? This was tested by playing 50 hertz sounds for one plant, 100 hertz sounds for another, and no sounds for the last for 6 hours a day every day. The sounds were played through speakers. The growth of each plant was measured every three days. The results of this experiment were as expected. The plant receiving 100 hertz of sound grew the tallest and healthiest. The plant receiving 50hz of sound grew the second tallest and the plant receiving no vibrations stayed the shortest. This proves that tone affects plant growth in a positive way.

Ellie Brauckbauer

JR-PS-002

Project Plant Sitter

When people go on vacation, they normally hire a plant sitter. What if they could water their plants differently before they left for vacation and there was no need for a plant sitter? I found out how to do this. I hypothesized that a plant given less water five days before the vacation would still be healthy by the end of the vacation because it would be accustomed to getting less water. Then, I grew four plants from seeds treating them the same and then I varied the amount of water being given to each plant for five days before the five-day vacation. I recorded their height, leaf growth, and color every other day of the vacation.

Throughout the experiment, the plant given more water grew two centimeters in height, remained deep green and grew 11 leaves. The control plant did not grow in height, went from deep green to yellowish and grew two leaves. The plant given the least amount of water did not grow in height, remained green and grew one leaf. The plant misted with the original amount of water grew two centimeters in height, went from deep green to yellowish and grew five leaves.

The plant given the most water before vacation did the best because its soil remained moist throughout the experiment so the whole time that plant had access to minerals in the water and it had plenty of moisture to supply other nutrients.

Riley Hunt

JR-PS-003

How Does Caffeine Affect Plant Growth

The purpose of this project was to see if caffeine actually will stunt your growth. I hypothesized that coffee will make the plants grow slower and stunt its growth, so the plants with coffee will be smaller. My research questions how caffeine affects plant growth.

This experiment involved daily work of measuring and marking down the measurements. This data shows that if it is pure coffee and non-brewed the plants had grown thinner. Also, the plants didn't look as healthy as the ones that had been watered with coffee.

If I were to change something about this project I would change the fact that I put about the same amount of seeds in each pot. Also, I would change the amounts of liquids each plant gets and be more precise. Many of the plants have been jumping amounts of lengths very quickly. Also, the plant's thickness had changed.

I have concluded that caffeine has some effect on plant growth. I know this because when the plants had grown closer together and with the caffeine in the soil had a dramatic effect. That is the conclusion that I have come to.

Light It Up

Though most crops are grown using sunlight as the light source, horticulture is rapidly growing in popularity. As more laymans are exploring horticulture it is being realized that it may not be quite as easy as it seems. In this experiment the researcher tested three different positively consumer reviewed indoor grow lights to see how the different kinds and amounts of light would affect a most commonly outdoor grown crop. After the sunflowers were planted the amount of time the lights were turned on was monitored. The researcher hypothesized that the light with different settings would grow the sunflowers closest to desired followed by the plant tub with multiple lights. After those the researcher hypothesized that the larger light would grow the third best well and that the plants with only one light. While the very first batch were growing they did not turn out well. This was because the light was too far away from the plants. The researcher adjusted the height that the lights were at and planted new plants. This batch failed as yet these plants got closer to desired. The researcher adjusted the height of the lights one more time, and this time the plants started to grow exactly how it is expected of sunflowers in the field. After growing the plants for roughly a month it is clear that the plants grown with multiple lights looked and behaved extremely close to a good crop.

Which Poo Is for You?

Ever since the start of agriculture, fertilizers have been used to help a plant grow remarkably better and to provide the nutrients plants need that might not be in the soil provided. There are many organic fertilizers used for farming, but many farmers and people in agricultural careers use chemical fertilizers to grow a sufficient crop. The test is based on using alpaca manure, chicken manure and cow manure in climates such as hot/dry and rainfall to see which fertilizer grows a remarkably better plant than what the farmers are using to grow their crops, and the climate that the plant growth is more sufficient in. After calculating the data, the alpaca manure grew the best plant in the hot/dry climate. In the rainfall climate, the cow manure produces the highest quality plant. The control climate produced the highest quality plant with the topsoil. This is because alpaca manure holds more moisture than the other manures, the cow manure can distribute the water evenly, so that the plant doesn't get over watered, and the topsoil works best in the control climate because it is able to deal with the right amount of water and light compared to the other climates and manures. Manure is a healthier, more pure option to fertilizer as it is free from chemicals and still does a purposeful job producing plant growth.

ABA-lanced Response: The Effect of External Abscisic Acid on Plant Stress Conditions

Droughts have significant damage not only to the economy and environment but to agriculture and crop yield as well. With the progression and severity of climate change, droughts have become more frequent and damaging. Abscisic acid (ABA) is a plant growth stress hormone that regulates stomata and other developmental processes. In plant leaves, stomata are the little pores that change in size and density depending on environmental factors and help with photosynthesis. Usually, during stress conditions, plants will naturally produce ABA to close their stomata, but whether spraying additional external ABA would affect plant health, as measured by leaf number and area, and stomatal size and density, were researched.

Radishes were grown in a mini greenhouse, drought conditions were implemented, and ABA was sprayed in three concentrations on three different experimental groups. Radishes' leaf area and leaf number, as well as stomatal size and density, were measured.

For the highest concentration of ABA sprayed, leaves were almost three times larger and leaf number increased by a statistically significant 186% compared to no spray. Those plants also had a 64% decrease in stomatal size, meaning that less water was able to escape from the radishes, and 41% greater density to allow for quick changes to the environment.

In the future, this work could allow for better plant survival during stress conditions like drought, and work as a more efficient and simple method to improve plant health!

Speed Germination

In what environment will a certain type of bean germinate faster? Based on my research, I think the beans will germinate faster in warmer temperatures, since that is what most types of beans tend to germinate in. I put the beans in paper towels with 16 squirts of water, put foil around the paper towels and put that whole thing in plastic ziplock bags. I did two for each temperature, making sure to check them every 24 hours. Before sealing the bags, I blew air into them and made sure not much of the air escaped.

The beans in room temperature germinated faster during a week's time I gave them, and two beans from one bag had roots sprout from them. The ones in the heated temperature cracked and didn't do much else after that, the ones in the cooler temperature shriveled up and got squishy. The beans in room temperature had growth of a root, so that means my hypothesis was wrong, since I had thought they would do better in the warmer temperatures.

A Stem Over the Rainbow

The purpose of this experiment was to determine what light color is best suited for plant growth. The researcher hypothesized that plants under red light would grow the best because chloroplasts, the green photosynthesis cells in plants, have been previously shown to photosynthesize with red light much more than green or blue light. The researcher grew Brassica Rapa plants under red, green, and blue lights to test this hypothesis. They also had a control group with no light. Each day of the experiment, the researcher measured and watered the plants. The researcher found that the hypothesis was correct. The plants growing under red light had a final height average of 5.525 centimeters, about a centimeter more than the second tallest plants, the plants without light. The plants without light had a final height average of 5.40625 centimeters, and the plants under green light grew to a final height average of 5.225 centimeters, over .4 centimeters taller than the plants under blue light, which had a final average of 4.7625 centimeters. This was due to the fact that chloroplasts do not use blue light well in photosynthesis. The chloroplasts can photosynthesize slightly better with green light, but also tend to reflect some green light, resulting in the plants not growing as well as those under red light, which chloroplasts can photosynthesize the most with, therefore creating the most energy the plant can use, resulting in a taller plant.

Nitrogen and Density Levels in Quinoa

Production agriculture is very important in many ways; it supplies us with food and raw materials and it also provides employment and a big revenue for our nation. Our producers are working to keep up with our growing population, while still staying efficient. Therefore, it is essential for our producers to use every strategy in order to achieve high yields, and to operate as efficiently as possible. Testing different levels of nitrogen and density in quinoa and trying to find the most efficient ways to produce crops is highly applicable to our producers. Research such as this can help producers become more efficient while producing higher yields and in turn, profits. I hypothesized that planting quinoa with 150 pounds of nitrogen fertilizer and 4 pounds of density would be the most efficient. My experiment was based on 5 nitrogen levels of 100 pounds, 125 pounds, 150 pounds, 175 pounds, and 200 pounds and density levels of 1 pound, 4 pounds, 7 pounds and 14 pounds. I took my averages from the 80 plots. After the crop had matured, I harvested, weighed and collected my data. I determined that the levels that worked the best were 1 pound of seed density and 100 pounds of nitrogen. Thus, my hypothesis wasn't supported.

Music and Its Relationships to Plants

The purpose of my science fair project was to see if plants like K-pop as much as I do and if they don't, I want to see which music they do grow the tallest with, country, jazz, rap, or no music at all. My hypothesis is If I use a fast song for the K-pop plant then I think the K-pop plant will grow the tallest because of the upbeat tempo. The Independent variables in this experiment are the music change, K-pop, rap, country, jazz. The dependent variable is the amount of growth in each plant. The variable that is changing is the music, however I am not changing the music for one plant, each of the 4 plants will have their own designated type of music they will listen to for the entire experiment. There is also one plant with no music at all, that is the constant. (Plant A-K-pop, plant B-country, plant C-Jazz, plant D- rap, plant E- no music) I measured each plant once a week for 4 weeks, and documented the data. I also watered them equally and provided the same amount of artificial light. The results were that plant C, the Jazz plant grew the tallest in the 4-week time. Also plant E, no music, grew taller than the other music types. After the experiment I found that my hypothesis was proven incorrect. I thought k-pops upbeat tempo would make plant A grow the tallest, but it seems that plant C, the Jazz plant grew the tallest in the four-week time period. Plant C actually was in the lead with its growth starting with week one and consistently grew taller than the rest of the plants. These plants seem to like the soothing effect that Jazz has over the fast tempo of the K-pop, rap, and country music. Plant E had no music and also grew taller than plants A, B, and D. This experiment showed that these plants prefer Jazz or no music at all. The plants did not grow as tall with K-pop, rap, or country music. Next time I would use different types of music such as classical or hard rock, and possibly try different kinds of plants too, like basil or sunflowers.