

**Project ID: 601****JR - Biomedical/Health Sciences, and Biomedical Engineering****Sidhaarth Parthiban**

Grade 7

The Cambridge School High School

Advisor: Melissa Mayne

*Effects of Various Concentrations of Nicotine on Monocyte*

Smoking increases the risk of cancer, respiratory infections, largely by adversely affecting the immune system. Heavier smokers are at higher risk of diseases. However, there is limited knowledge of the role of nicotine (a major addictive component of tobacco) in these adverse effects. Our experiment assessed nicotine's effect on the survival of monocytes/macrophages that are abundant in the lungs and are critical part of the innate immunity. This will aid to improve health and enhance awareness about smoking and its effect on the human body. The experiment emulated smoking patterns by testing the effect of different concentrations of nicotine on cell death. A monocytic cell line was treated with four concentrations of nicotine and a negative control was included for comparison. We observed cell morphology under the microscope, followed by imaging. Additionally, the number of live versus dead cells was determined using a hemocytometer.

Our results indicate that nicotine increases monocyte death in a dose-dependent manner, with 1M nicotine being statistically significant (p value < 0.05). The results suggest that nicotine, particularly at higher concentrations, is a factor in increasing the risk of disease in smokers, via increasing the death of cells that are important in immunity.

Given the importance of monocytes in fighting infections and nicotine's effect on monocyte viability, we conclude that exposure to nicotine should be avoided whether through active or passive smoking or chewing tobacco. Future directions could involve correlating dose-dependent findings of monocyte viability with monocyte count in blood of individuals with different smoking patterns.

**Project ID: 602****JR - Biomedical/Health Sciences, and Biomedical Engineering****Steven Chen**

Grade 7

Pacific Trails Middle School

Advisor: Adam Milhollan

*Magnetically-Powered Micro Train*

The objective of the project is to develop a magnetic micro-train that can be remotely controlled by an external magnetic field to carry and release drugs to fight against diseases. A distinctive advantage of the micro-train developed in the project is that the train is composed of biocompatible hydrogel, which holds magnetic nanoparticles in its head for navigation and power. The cargo parts are made of a hydrogel, which contains 3D crosslinked polymer chains, so they will be able to hold drugs in their pores and then gradually release the drugs into a localized area. The magnetic micro-train was designed to be small enough for drug delivery and disease treatment inside the body.

The first step was to create a PDMS mold for the train with 3D printing. Next, a hydrogel mixture, consisting of PEGDA hydrogel and magnetic nanoparticles of different concentrations, was formed as the train head. This would allow for the micro train to be controlled by an external magnetic field. As a mock payload, green food dye was added to a separate vile of the hydrogel mixture to demonstrate the release of drugs. Then, through UV polymerization, the micro-train was solidified in the mold and then released for testing. The test results showed that the magnetic micro-train can be guided by the external magnet. The results also showed that the food dye (in lieu of drugs) carried by the magnetic microtrain gradually diffused out of the train cargos, and completely diffused away in 12 hours.



Project ID: 603

JR - Biomedical/Health Sciences, and Biomedical Engineering

Phoebe Roy

Grade 7

Nazareth School

Advisor: Marilyn Reed



What UPF Fabric is the Best at Repelling UV Radiation?

Skin cancer is one of the most common types of cancer, and is caused by prolonged exposure to UV radiation. UV radiation damages the DNA in our skin cells, producing genetic defects. So how can we effectively protect ourselves from UV radiation? One of the ways is to wear UPF fabrics. UPF clothing can help reduce UV exposure significantly, protecting our skin from both UVA and UVB waves.

I wanted to know which fabric is the best at effectively blocking UV rays, so that the results of my experiment can inform others. Cancer is a serious topic, because it takes the lives of so many innocent people. Knowing which fabrics can successfully limit prolonged exposure to UV radiation can help reduce the number of skin cancer cases.

My project examined different UPF fabrics to determine which was the best at blocking UV radiation. Each fabric was put under a UV lamp, and a radiometer would record how much UV rays were penetrating through. The less UV rays that penetrated the fabric, the more protection that fabric would give. It is hypothesized that polyester fabric has a higher percentage of repelling UV radiation.

The results indicated that the polyester fabric was the best at blocking UV radiation compared to the other fabrics. It allowed only about 0.09% of the UV rays to penetrate. Whereas wool allowed about 0.1% of the UV rays through. Cotton allowed about 0.3% of the UV rays through. Bamboo allowed about 1% of the UV rays through. Nylon performed the worst out of the five fabrics, allowing 2% of the UV rays to penetrate through. Polyester may have done well because it is made of synthetic plastic fibers that can disrupt UV light. It is also tightly woven, making it difficult for UV rays to penetrate through.



Project ID: 604

JR - Biomedical/Health Sciences, and Biomedical Engineering

Dhruv Bantval

Grade 8

Pacific Trails Middle School

Advisor: Ellen Main



Smart Glove with ASL-to-Speech Conversion to Assist the Hearing Impaired

Summary: In this engineering project, a prototype of a device used to convert American sign language to speech was developed to assist the hearing impaired. The device takes ASL letters, words, and numbers as inputs, and decodes them with a 95%-100% accuracy.

**Project ID: 605****JR - Biomedical/Health Sciences, and Biomedical Engineering****Aminah Siddiqui**

Grade 7

Bright Horizon Academy

Advisor: Najwan Naserelddin

*Vitamins Against Free Radicals*

The experiment aimed to test the effect of vitamins C, E, D, and B12 on the survival, health, and regeneration of planaria, as well as their vulnerability to free radicals.

It was hypothesized that vitamin C will protect the planaria against the free radicals best.

In the experiment, petri dishes were labeled with different combinations of spring water, carbon dioxide, and various vitamins. Spring water and each of the other substances were added to their respective petri dishes, and planaria tails were added to each dish. The number of living planaria and growing heads were observed and recorded daily for six days.

The results indicated that exposure to carbon dioxide had a significant negative impact on planaria viability, with an average reduction of 61% compared to the control group in spring water. Among planaria exposed to carbon dioxide and low vitamin treatments, vitamin C had a 33% lower average viability rate than the control, while vitamin B12 had a slightly lower average rate of 1.6%. In groups exposed to higher vitamin treatment dosages, vitamin C had a significantly lower viability rate with a 40% decrease compared to the control, while vitamin B12 had a slightly higher rate. Overall, the results suggest that exposure to carbon dioxide has a more significant negative impact on planaria viability than exposure to low or high concentrations of vitamins. The study concludes that supplementing dissected planarians with Vitamin B12 followed by Vitamin E may help promote their health after dissection and exposure to free radicals.



Project ID: 606

JR - Biomedical/Health Sciences, and Biomedical Engineering

Andreas Rull

Grade 8

St. John School

Advisor: Gena Heins



Too Hot for Sopt

I built a collar that prevents the risk of heatstroke in dogs. I pursued this project because I was tired of hearing how many dogs have injured or killed by heat stroke. This is why I designed a collar that notifies a dog owner if their pet shows signs of overheating. I did this by using an app based wireless thermometer and integrating it into a standard dog collar. In my research, I learned that normal dog temperatures were taken through their anus, and that skin readings would not be as accurate. My testing, proved this to be true. The readings I was getting, were all below hypothermic for dogs. I also noticed that they averaged around 10°C below the average temperature of 38.3 to 39.2°C. So, I adjusted the margin of alerts from 38°C to 40°C, to 25°C and 32°C. My final design for detecting heatstroke was more accurate than the initial design. I believe I would have found more success in adding more features such as GPS tracking, and a heartrate monitor to solve other problems dogs may face, such as when an owner loses their dog.



Project ID: 607

JR - Biomedical/Health Sciences, and Biomedical Engineering

Zakari Sayed

Adam Jaimovich

Grade 7

The Rhoades School

Advisor: Roxanne Hunker



Efficacy of Various Spice Extracts in Combating Potential Stimulant Hazards

Caffeine pollution is a form of water pollution that has devastated marine life and has been a lasting problem in the United States. We hypothesized that two spices, turmeric and cinnamon, might counteract the stimulatory effects of caffeine. We decided to monitor the heart rate of a *Daphnia magna* when spices were introduced to caffeine-infused water.

We obtained more than 50 *Daphnia*, and prepared ten test solutions, including caffeine solutions, spring water as the control and spice solutions of various concentrations. We tested five spices: turmeric, cinnamon, garlic, coriander and ginger. In order to mix the caffeine or spices with water, we carefully weighed the substances, then vortexed the solutions with spring water for two minutes. We recorded the control heart rate for the *Daphnia*, then placed the *Daphnia* in 10 ml of 0.5% caffeine-infused water. After two minutes, we transferred the *Daphnia* to a culture slide and recorded the heart rate. We then added one drop of the test spice solution and allowed the *Daphnia* to sit for three minutes. We then measured the heart rate again.

The normal resting *Daphnia* heart rate ranged between 140 and 170 bpm. After the *Daphnia* spent two minutes in the caffeinated water, heart rate rose to between 200 and 240 bpm. We found that one drop from a solution of 5% turmeric returned the *Daphnia*'s heart rate to an average level of approximately 165 bpm. None of the other spices appeared to reduce *Daphnia* heart rate, with the exception of 5% cinnamon, which lowered the heart rate to a fatal extreme. Unlike the cinnamon all of the *Daphnia* that were tested with turmeric continued to survive for many days after participating in the experiment.

We had hoped that turmeric would counteract the effects of caffeine and lower *Daphnia* heart rate and our hypothesis was supported by our results. None of the other test spices appeared to have positive effects on *Daphnia* heart rate, but we were pleased that the turmeric appeared to counteract the stimulatory effects of caffeine. Based on our results, we think it might be useful to conduct further studies regarding how the introduction of turmeric might possibly help negate impacts of caffeine-infused wastewater on marine life.

**Project ID: 609****JR - Biomedical/Health Sciences, and Biomedical Engineering****Omar Aly**

Grade 7

Bright Horizons Academy

Advisor: Najwan Naserelddon

*The Effect of Weight Training for Throwing a Football*

This science fair project aimed to investigate the effects of different types of training on football throwing accuracy and distance. Four groups of participants were tested: one group practiced throwing only, one group practiced weight training only, one group practiced both throwing and weight training, and a control group received no training. The participants' throwing accuracy was measured at three distances: 5, 10, and 15 yards. The results of the experiment revealed interesting findings. After 4 weeks of training, the first group that focused on throwing training showed a significant improvement of 35.41% at 5 yards, a slight decrease of 1.87% at 10 yards, and a moderate improvement of 4.87% at 15 yards. The second group, which combined throwing and weight training, demonstrated an impressive improvement of 47.45% at 5 yards, 23.98% at 10 yards, and 5.94% at 15 yards. The third group that focused solely on weight training also showed improvements of 32.31% at 5 yards, 6.34% at 10 yards, and 31.98% at 15 yards. In contrast, the control group that received no training showed no improvement. These findings suggest that combining throwing and weight training can be an effective way to improve throwing accuracy and distance, while weight training alone can also lead to significant improvement in throwing accuracy at shorter distances. In conclusion, the results of this science fair project demonstrate that different types of training can have a significant impact on improving football throwing accuracy and distance. The combination of throwing and weight training was found to be the most effective, resulting in significant improvements at all three distances tested. Weight training alone also showed a positive impact on accuracy, particularly at shorter distances. In contrast, simply practicing throwing without weight training did not result in significant improvements. These findings suggest that athletes and coaches should consider incorporating both throwing and weight training into their training regimes to maximize their potential for improvement in football throwing accuracy and distance. Future studies could investigate the long-term effects of these different types of training on throwing performance and explore other training strategies to further optimize football throwing ability.



Project ID: 611

JR - Biomedical/Health Sciences, and Biomedical Engineering

Eva Cantorna

Grade 7

Nazareth School

Advisor: Marilyn Reed



Do People with Different Eye Visions Have Different Blind Spots?

This project examined the blind spots of people who wear glasses/contacts and people who don't to determine if the blind spot distance is differentiated between the two groups. I hypothesized that students who wear glasses would have a bigger blind spot distance than those who have 20/20 vision. I tested this by having about 50 students hold a paper that has an x and a circle on it, which are about 3 inches apart, arm's length away. They, then, cover their right eye, stare at the circle, and move the paper closer until the "x" disappears. After completing this, they repeat it with the other eye but stare at the "x" instead and move the paper until the circle disappears. I would then measure and record the distance of the paper to their nose bridge with a metric ruler.

Results indicated that the initial hypothesis was supported--people who wear glasses/contacts had the bigger blind spot compared to people who do not wear either. The difference in distances was very small, but there was still a deviation in measurements of people with glasses and people with 20/20 vision.



Project ID: 612

JR - Biomedical/Health Sciences, and Biomedical Engineering

Sophia Birch

Grade 6

City Tree Christian School

Advisor: Michelle Lee



The Effect of Different Edible Liquids in Protecting Model Esophagus from Swallowed Batteries

The purpose of this project was to look into the issue of button batteries being swallowed by young children. The number of batteries being swallowed has risen rapidly in recent years, causing severe injuries and deaths. I wanted to find out if there was a substance that could be swallowed immediately to decrease the damage and save lives. My hypothesis was that if you swallow a thick substance it will coat the battery and stop it from causing so much damage as it will act as an electrical resistor.

To conduct this experiment I made a model of the esophagus and swallowed button battery with two circles of ham (representing the esophagus) and a battery between them. I added my variables honey, agave syrup and antacid liquid to each category, and water to my control group to represent saliva.

The results were that water and antacid prevented the most damaged surface area when measuring the diameter but my visual observations were that the ham was incredibly thin, almost transparent, meaning the damage was more severe and diameter was not the best measurement. The honey and agave test ham were closer to the original state, which supported my hypothesis.

Overall, my conclusion was that the honey category prevented the most damage so a child should be given it if they swallow a button battery and are +12 months old. If they are younger, they should be given agave syrup (to avoid infant botulism) as it was a close second. I would like to further the investigation by looking at the damage cells level under a microscope.