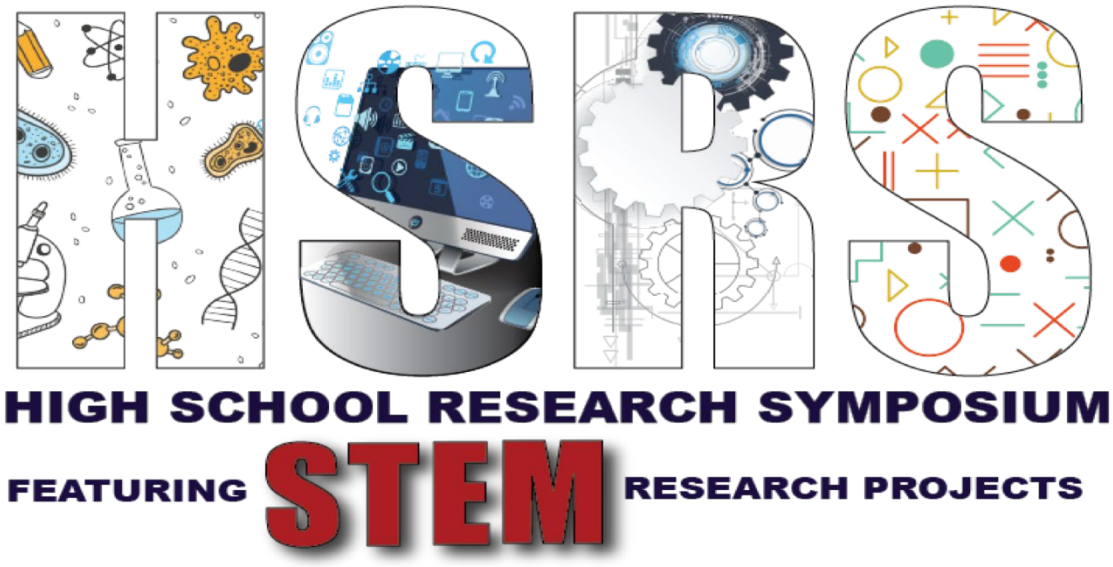
23rd Annual High School Research Symposium



sponsored by

Center for Mathematics, Science, and Technology
at Illinois State University

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Welcome

We are thrilled that you have chosen to join us to celebrate your accomplishments in research! You've worked hard, overcome challenges, and should be proud of your achievements. Your presentation today gives you the opportunity to share your research with an audience of ISU professors, ISU students, and other high school students. Taking part in the Symposium allows you to gain valuable experience in presenting your research to a diverse audience, network with ISU community members, and gain an appreciation of the work of your peers. Don’t forget to add this research presentation to your résumé, internship or job application, scholarship application, or college/university application!

Schedule of Events

8:30 – 9:30 am	Poster Check-In and Setup
9:30 – 10:30 am	Poster Session I (even numbers)
10:30 – 11:30 am	Poster Session II (odd numbers)
11:30 am – 12:45 pm	Lunch on your own
12:45 – 1:00 pm	Keynote Speaker: Anindita Saha
1:00 – 1:15 pm	Keynote Speaker: Aalimah Akinosho
1:15 – 1:30 pm	Keynote Speaker: Sadia Sultana
1:30 pm	Awards and Closing Remarks

Acknowledgments

This event would not be possible without the staff at the Center of Mathematics, Science, and Technology:

Ashley Waring-Sparks
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Esther Awusah
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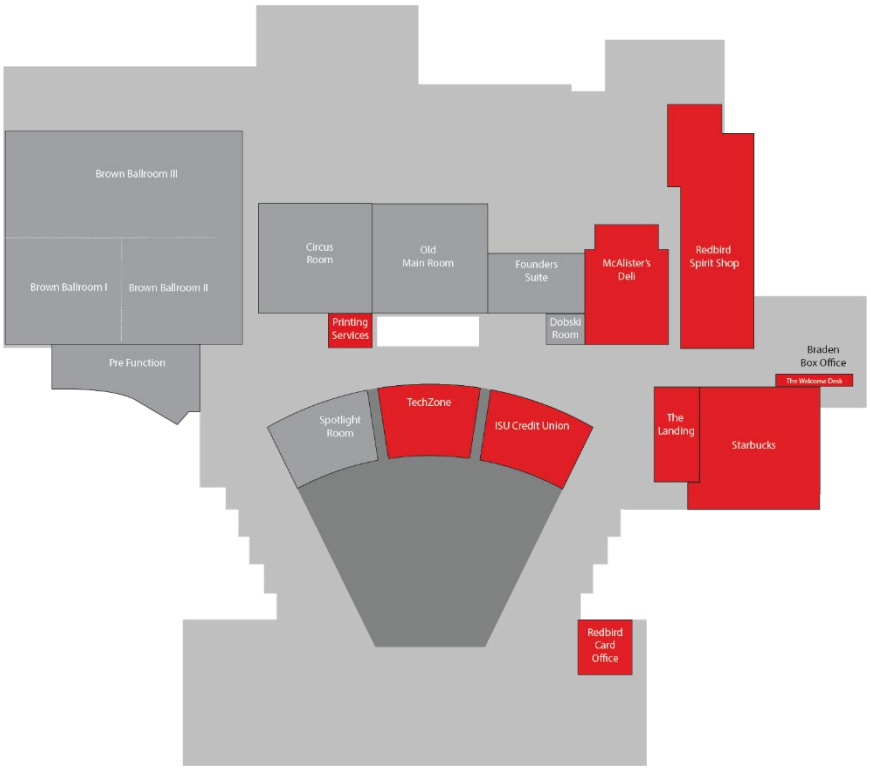
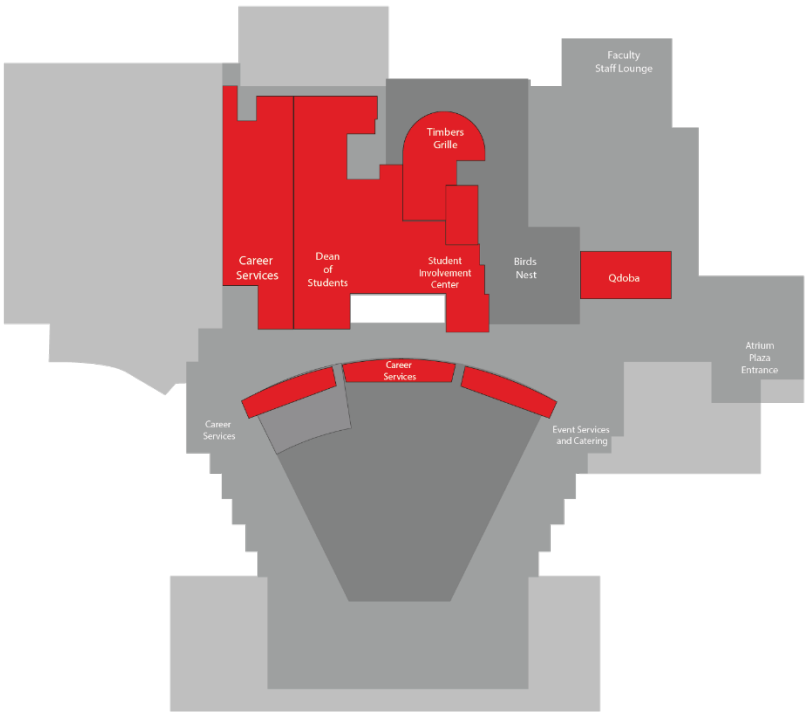
Ryan Borchardt
Julia Tortorici

Finally, thank you to all presenters, as well as the teachers and researchers supporting students' work!

Bone Student Center Dining Options

There are several dining options throughout the Bone Student Center. Starbucks, The Landing, and McAlister's Deli are all located on the first floor, shown in the map to the right.





Timbers Grille and Qdoba are located on the second floor, shown in the map to the left.

Poster Session I - Abstracts

[2] Utilizing Artificial Intelligence and Single-Cell RNA-seq Data for the Investigation and Discovery of Novel Genetic Biomarkers in Age-Related Macular Degeneration

Ibrahim Arif | IMSA/RISE

Age-related macular degeneration (AMD) is a progressive neurodegenerative eye disorder characterized by the degeneration of the retinal pigment epithelium (RPE) and photoreceptor resulting in permanent vision loss. With no definitive treatment, it is crucial to diagnose AMD early to prevent progression to advanced stages. Artificial intelligence (AI) and machine learning (ML) have revolutionized healthcare by advancing clinical diagnosis leveraging their ability to analyze vast amounts of patient data and accurately predict future outcomes. This experiment located novel genetic biomarkers utilizing *Hygieia*, an open-source AI/ML pipeline to better understand AMD's etiology for potential treatment development, improve clinical diagnosis, and assess the applicability of this model in finding biomarkers significant to AMD. Differential gene expression analysis was conducted on a dataset from the Gene Expression Omnibus (GEO) and the resultant differentially expressed genes were run on *Hygieia* to discern statistically significant genes. Gene ontology analysis was performed and a classifier was constructed to analyze the prediction performance of the genes in diagnosing AMD. This experiment supported earlier findings linking RPE dysfunction and concurrent inflammatory mechanisms in AMD's pathogenesis. Low p-values were obtained from the Chi-Sqaure test for *SLC1A4* ($p<0.0001$), *BCSIL* ($p<0.0001$), and *SNHG17* ($p<0.0001$), which were proposed as novel biomarkers due to their high significance and limited information in literature concerning AMD. Further research is needed to identify their specific role in AMD's etiology to identify therapeutic targets. This experiment elucidated that AI/ML technologies can identify significant biomarkers to predict disease.

Keywords: Age-related macular degeneration, machine learning, genetic biomarkers, diagnosis, disease pathogenesis

[4] 5-hydroxymethylcytosine and TET Enzymes in neuroblastoma

EmmaLi Isham | Illinois Mathematics and Science Academy

One of the hallmarks of aggressive neuroblastoma is amplification of the MYCN oncogene which defines groups of patients with poor prognosis. The Applebaum Lab has shown that in MYCN-amplified neuroblastoma, 5-hmC (a DNA modification of open chromatin placed by the Ten-Eleven Translocation (TET) proteins) and H3K27me3, a marker of closed chromatin, co-localize. This co- localization results in the repression of genes that would lead to non-malignant differentiation if expressed. We hypothesized that an improved understanding of these mechanisms would allow us to target pathways that promote aggressive neuroblastoma. To test this, we knocked out TET2 and TET3 proteins in SK-N-BE2 neuroblastoma cell lines using a lentivirus CRISPR vector system to deliver Cas9 and sgRNAs. After confirming knocking out the TET 2/3 proteins, we found a weaker presence of 5-hmC among the cells. We then measured cellular proliferation of three unique clones using the MTT assay and found that the SK-N-BE2 cell lines were extremely confluent. This interfered with the results of our MTT assay and more testing is needed to form a conclusion. Thus, knockout of TET2 and TET3 proteins in MYCN-amplified neuroblastoma cells reduced 5-hmC levels and potential impaired cellular proliferation, suggesting that targeting these proteins may be a promising therapeutic strategy.

Keywords: Pediatric Cancer, neuroblastoma, cancer treatment

[6] A Comparison of *Zingiber officinale* Mediated and Chemically Synthesized Copper Nanoparticles Through Their Effects on *Drosophila melanogaster* Locomotion for In Vivo Medical Applications

Jenna Ahn | Oak Park and River Forest High School

This experiment studied the effects of ginger-mediated and chemically synthesized copper nanoparticles (CuNP) on the model organism *Drosophila melanogaster* (*D. melanogaster*). Nanotechnology is a rapidly evolving field in which nanoparticles (NP) are pioneering developments, particularly in medicine. Metal NPs have been shown to display antibacterial, antiviral, and anticancer properties. However, the in vivo cytotoxic effects of these particles are not fully known. Much research has suggested the incorporation of biological materials to increase the biocompatibility of these particles. To test this hypothesis, this experiment investigated chemically synthesized CuNP compared to ginger-mediated CuNP. *D. melanogaster* was analyzed to further understand the effects of CuNP on living organisms. After NP characterization using TEM, DLS, and UV-visible spectroscopy, 3 separate dosages of the NP were incorporated into fly media. A climbing assay was used to observe the effects on locomotion and geotaxis of the *D. melanogaster* adults and their larvae. A 2-way analysis of variance (ANOVA) showed no statistically significant differences in climbing ($p > 0.1$ for both copper and ginger CuNP) however did find substantial evidence to attribute variation in larval crawling to CuNP treatment when compared with a control ($p<0.001$). These findings support the concerns of present research regarding the toxicity of chemically synthesized NPs in particular. With further research, biologically synthesized NP could be developed and implemented in academic, commercial, and military settings as biologically compatible antimicrobial, antiviral, and anticancer agents.

Keywords: Copper nanoparticles, Drosophila melanogaster, nanoparticle synthesis, ginger-mediated biosynthesis, chemical synthesis

[8] A Meta-Analysis on the Evaluation of the Use of *Valeriana officinalis* as an Alternative to Melatonin for Individuals with ADHD

Julia Casto | Oak Park and River Forest High School

Attention-deficit/hyperactivity disorder (ADHD) is characterized by symptoms such as inattention, hyperactivity, and impulsivity. Some symptoms not commonly recognized are persistent sleep disturbances or disorders. Difficulty sleeping can significantly decrease academic performance, impair cognitive functioning, and decrease quality of life, compounding the symptoms of ADHD. Melatonin, a commonly used sleeping aid, has varying degrees of effectiveness on those with ADHD. Valerian root, on the other hand, is an herb frequently researched worldwide for its proposed effects on sleep. Previous research has demonstrated that valerian holds promising potential as an effective alternative to melatonin. To establish the effectiveness of valerian root on individuals with ADHD, this meta-analysis used data in previously published literature conducted with a focus on valerian root and its effects on those with ADHD-induced sleep disturbances. It was observed that valerian root had a significant positive impact on the issues of staying (p-values of 0.012 and 0 from two data sets) and falling asleep (p-values of 0.00003 and 0.000000001), shown through high reduction rates and calculations from McNamer's test. These findings demonstrate that valerian root may be effective as a sleeping supplement that those with ADHD can use to influence sleep positively.

Keywords: Attention-deficit/hyperactivity disorder (ADHD), melatonin, neurodevelopmental disorder (NDD), sleep disorders, valerian root

[10] AI in medicine: Generating Synthetic Medical Data and Diagnosis with Precision
Atharva Dutta | Metea Valley High School

Diagnosis of a disease is prone to inaccuracies even by the most experienced doctors. However, the biggest issue is the difficulty in detecting certain ailments (namely, IgA nephropathy, Celiac disease, diabetes, etc). Lastly, due to the increasing population, there only being slightly over 1 million active physicians the time it takes to get an appointment and the resulting diagnosis by a doctor is extremely long. To be able to mitigate all these problems we need an effective and straightforward solution thus, the application of AI to disease diagnosis may be the step forward in helping lower the burden on doctors and decreasing the time required to diagnose a disease, while not compromising safety and accuracy. The type of data also has significance most data are usually images, but the use of patient laboratory tests to identify general diseases is also necessary. However, training AI requires a lot of data, which is hard to obtain due to patient privacy laws, thus the generation of synthetic data is a must to help meet the need for accurate and generalized data. This literature review is a comprehensive method to generate the most effective AI to generate synthetic data and diagnose disease. This paper actively looks at the positives and negatives of certain methods for disease diagnosis as well as data generation and lastly identifies a few relevant works that were reported. The work that was reported showed great success and even higher efficiency and accuracy than humans, thus providing us with confidence that AI's use is a possible venture that must be looked into greatly.

Keywords: Bioinformatics, data science, medicine, Generative Pre-trained Transformer, Medical Diagnosis

[12] Antibiotic Resistance pertaining to vegan vs. animal manure soil
Niyati Nair and Soumya Sulakhe | Oswego High School

For decades, livestock have been fed antibiotics to promote growth, treat infections, and prevent diseases in crowded and often unsanitary conditions. "Worldwide it is estimated that 66% of all antibiotics are used in farm animals, not people." (ASA 1). However, the extensive use of these antibiotics has resulted in the emergence of highly drug-resistant bacterial pathogens. This led us to our hypothesis that if we use animal manure based compost in the growth of radishes, then it will allow antibiotic resistance to develop in the bacteria found in the vegetable, due to the high rates of antibiotic administration in livestock.

Keywords: Antibiotic Resistance, soil, plants, vegan soil, manure soil, bacteria

[14] Assessing the Impact of Vegetation on Lake Surface Area for Freshwater Conservation in Five Emerging Economies
Derick Cao | IMSA/RISE

Purpose: This study examines anthropogenic factors affecting lake water evaporation, emphasizing the role of surrounding vegetation. It offers insights for policy-making to preserve lakeside vegetation, potentially reducing evaporation rates. The research is significant in understanding lake evaporation dynamics, aiding in balancing urban development and vegetation conservation to mitigate ecological and economic impacts of lake depletion.
Procedure: The hypothesis posits that human activities and nearby vegetation significantly influence lake shrinkage, with a predicted positive correlation between increased vegetation and higher evapotranspiration rates. The study also hypothesizes that urban expansion near lakes boosts evaporation. It analyzes global lakes' water surface data and vegetation indices from 1985 to 2018, using the Pearson Correlation Coefficient. The focus is on Brazil, Russia, India, Indonesia, and China, comparing their lake shrinkage and vegetation indices with global trends.

Conclusion: The findings show varied correlations among these countries. Brazil and Indonesia have weak correlations, while China shows mixed results. Russia and India display strong positive correlations. Notably, India saw an increase in disappearing lakes from 2000 to 2018. The study notes a trend of smaller lakes due to shrinking surface areas. Conclusively, both vegetation and human factors are significant in lake shrinkage, underscoring the need for integrated environmental and urban planning policies.

Keywords: Anthropogenic, Evaporation, Freshwater Lakes, Satellite Images, Vegetation

[16] Biochemical Characterization of Developmentally-Regulated GTPase Rbg2/Gir2 Under Influence of K+

Jonathan Ouyang | University Laboratory High School at University of Illinois Urbana-Champaign

Developmentally-regulated GTPases, or DRGs, are a family of GTPases that are not only highly conserved across the Eukarya domain and play fundamental roles in translation and polysome formation but also are implicated in a variety of cancers and human developmental disorders. The DRG family consists of two paralogs, DRG1 and DRG2. DRGs additionally have binding partners known as DRG family regulatory proteins, or DFRPs, which DRGs predominantly exist in complex with. Most of the literature focuses on studying DRG1, while leaving DRG2 largely uncharacterized. DRGs, as well as small GTPases in general, have been shown to be cation-dependent and possibly potassium-selective. The yeast ortholog of DRG2, Rbg2, is uncharacterized and relatively unstudied. Recombinant 6His-tagged Rbg2 and the DFRP2 ortholog Gir2 were expressed in *Escherichia coli* BL21 (DE3) with Isopropyl β- d-1-thiogalactopyranoside induction and purified with nickel-affinity fast protein liquid chromatography as well as Size Exclusion Chromatography. GTPase assays were done with malachite-green colorimetric assays. Here, the GTP hydrolysis activity of recombinant Rbg2 with and without its binding partner Gir2 is characterized for the first time (kcat of 1.598 ± 0.061min−1 (Vmax is 0.711 ± 0.027mol·min−1·g−1) and Km of 106.31±14.19 μM GTP), showing similar biochemical characteristics to DRG1. Rbg2 is further shown to be a slow, temperature-dependent GTPase that is downregulated by the presence of K+ ions in contrast to the K+ dependency of DRG1 orthologs.

Keywords: Developmentally regulated G-protein, GTP-binding protein, ribosome binding GTPase, biochemical characterization, cation-dependent GTPase

[18] Building a Reconstructed Prairie on Our School Campus

Mara Haiduc, Taylor Mitchell, and Nahla Mokkath | Downers Grove South High School

A reconstructed prairie was designed in the detention basin on a west suburban Illinois high school campus to increase biodiversity, beautify the campus, and attract wildlife in order to incorporate the naturalized area to the environmental high school curriculum and research projects. Different types of prairies and various seed mixtures were researched in order to find the perfect plant species that would thrive in the heterogeneous environment. The seed mixtures were curated for different levels of soil wetness and visibility restrictions. It was determined that a shortgrass echinacea mix would thrive at the top at our downward sloping detention basin; then towards the bottom of the slope, a pollinator mix containing wildflowers and taller grasses would work best at that level of soil moisture and work best to increase biodiversity for potential future research; and lastly, the land at the bottom of our prairie was for the detention basin seed mix that would thrive in a wetland environment. The seeds were successfully planted in rows where sod was removed and replaced to prevent erosion. Over time there will be many opportunities to utilize the reconstructed prairie area and the possibilities of what can be researched are endless.

Keywords: Plants, prairie, growth, seeding, environment

[20] Do Levels Of Tetrahyrdrobenzo(a)pyren-7-ol Increase The Growth Of Breast Cancer Tumors?
Vy Tran | Niles West High School

Purpose: With over 200,000+ cases of breast cancer yearly, and an increase of 17% in the past 30 years, environmental factors are rising to become a leading cause. Through the knowledge of a rapid increase in breast cancer tumors today, environmental effects are a leading cause, including PAHs; there are over 10,000 different types, one being: Benzo(a)pyrene. This PAH, is a probable carcinogen towards breast cancer, altering the cells using adducts; Tetrahydrobenzo(a)pyren-7-ol is an alternative, still containing similar effects. Exposing Physarum Polycephalum with Tetrahydrobenzo(a)pyren-7-ol will show either a decrease or increase in growth.
Procedure: When adding Tetrahydrobenzo(a)pyren-7-ol with non-nutrient agar will allow for the Tetrahydrobenzo(a)pyren-7-ol to be throughout the agar. This then will let the Physarum Polycephalum grow within the agar plate, exposing Physarum Polycephalum with the Polycyclic Aromatic Hydrocarbons.
Conclusion: In conclusion, the levels of Tetrahydrobenzo(a)pyren-7-ol does increase the growth of breast cancer tumors. The mutant of Benzo(a)pyrene, a probable carcinogen towards breast cancer, is Tetrahydrobenzo(a)pyren-7-ol (TBaP). Benzo(a)pyrene is found either man-made, or naturally. This then affects vegetation, humans, and environment; which comes from the incorrect combustion of fossil fuels. The growth of Physarum Polycephalum exceeded the recommended daily exposure by the FDA. .3mg of TBaP, .1mg higher than the recommended concentration, exceeded in growth; furthermore, showing the increase in breast cancer tumors.

Keywords: Climate Change, Global Warming, Carcinogens, Breast Cancer

[22] Drug Store vs. High End Make-up
Tyler Boecker, Nalani Lopez, and Olivia Schwab | Oswego East High School

Abstract not provided.

Keywords: make-up, quality, price, longevity, effects

[24] Effects of initial domain packing in lipid monolayer in-plane collapse
Deepanjali Samal | Illinois Mathematics and Science Academy

In this study, elasticity is used to model the compression and collapse of lipid monolayer systems computationally. Fluorescence microscopy images of lipid monolayers on an instrument called the Langmuir trough show patterns of domains (a group of highly compact lipids) surrounded by a softer matrix, allowing us to compare our computational results to experimental results. We recreate collapses in domain organization through shear band formations, which are shocklines of high distortions. Previous computational experimentation has studied shear banding from the initial domain organization of hexagonal packing. However, domain shape and packing may differ depending on the lipid monolayer composition. In this computational experiment, the sizes, shapes, and packing of the domains are manually varied to determine the impact of the initial domain organization on the final configuration. Results showed that shear bands seem to form mostly tangent to the domains, even though domains are not required to initiate shear bands. The shear bands also mirror off the outer edges due to high deformations. Reaction force data shows that the addition of more condensed domains cause shear bands to form earlier in the simulation. We think this is due to the higher surface fraction of the stiff material, causing a higher effective stress within the matrix. This is important as we gained insight on where the stress localizes around the domains, and how the surface fraction of stiffer domains affect collapse. This provides a framework for understanding the mechanism behind experimental lipid monolayer collapse.

Keywords: lipid monolayer, lung surfactant, shear banding, continuum mechanics, finite element simulation

[26] Effects of Liraglutide on modulating GABA neurotransmission and increasing dopamine levels using L-dopa and carbidopa to reduce of ethanol addiction in *Drosophila melanogaster*

Laila Rozenberg | American Heritage School – Broward

The research investigates how voluntary Liraglutide administration modulates GABA neurotransmission and examines the potential dopamine level enhancement via voluntary intake of L-dopa and carbidopa to combat ethanol addiction in *Drosophila melanogaster*. The aim is to propose novel pharmacotherapeutic strategies for substance use disorders. Alcohol Use Disorder (AUD) is a pressing global health issue. This study focuses on understanding addiction neurobiological mechanisms, emphasizing GABA and dopamine pathways, to introduce innovative treatments. Using *Drosophila* as a model, the experiment replicates human addiction traits, demonstrating fly resilience to ethanol toxicity and preference for ethanol consumption. The procedure encompasses various assays: monitoring GABA neurotransmission with behavioral assays, quantifying dopamine levels using ELISA, and assessing ethanol preference via a Y-maze. Results indicated notable GABA modulation and reduced ethanol preference in Liraglutide-treated flies, supporting the primary hypothesis. However, there was inconclusive data regarding enhanced dopamine levels. Data reliability was affected by limited funding, time constraints, and initial fly mortality issues. Repeating experiments with diverse samples and dosages improved accuracy. Implementing these findings in practical settings could lead to novel pharmaceutical interventions for alcohol addiction. Future research may explore alternative GLP-1 analogs, refine delivery techniques, and transition to human trials for better translatability from animal models. This study illuminates potential pharmacological approaches for alcohol addiction, but further investigation is essential to overcome limitations and fully exploit these findings in clinical practice.

Keywords: Drosophila, alcohol, addiction, dopamine, GABA-neurotransmission

[28] Effects of Vitamin E Acetate Exposure on Endothelial Cells Permeability can be Reversed by Sphingosine-1-Phosphate: A Novel In-Vitro Model With Applications for Potential Inflammatory Preventative Treatment for Electronic Cigarette Lung Injury

Daniel Epshtein | Oak Park and River Forest High School

Electronic cigarette or vaping product use-associated lung injury (EVALI) is a syndrome characterized by acute respiratory failure accompanied by alveolar inflammation involving monocytic and neutrophilic cells. Recent studies suggest that vitamin E acetate (VEA) plays a crucial role in the development of EVALI, according to epidemiological evidence. Sphingosine-1-phosphate (S1P) is a central lipid molecule in sphingolipid metabolism utilized worldwide to treat inflammatory diseases, which has the potential to be a preventative treatment for EVALI. However, no recent studies have observed S1P as a preventative treatment for EVALI. This experiment utilized a novel in-vitro model, Human Pulmonary Artery Endothelial Cells (HPAEC), to better understand the effects of VEA exposure on primary endothelial cells and the potential of S1P as a preventative treatment after VEA exposure. The results of this experiment were analyzed by a one-way ANOVA to support S1P as a protective reagent and reflect the results of similar studies that did not observe a relation between VEA exposure and S1P treatment (p<0.001). Further research is needed to evaluate how S1P can be used in academic and commercial settings and to speed the process from the laboratory to the clinic, where it can help individuals.

Keywords: Sphingosine-1-Phosphate (S1P), vitamin E acetate (VEA), reagent, Human Pulmonary Artery Endothelial Cells (HPAEC), novel in-vitro model, translational model

[30] Elucidating the Efficacy of Herbal Extracts as Novel Antidepressants in *C. elegans*

Bianca Summers | Oak Park and River Forest High School

Major Depression Disorder (MDD) is a condition affecting 17.8 million Americans and can be associated with a deficiency in 5-Hydroxytryptomine (5-HT). Current treatments for MDD include Selective Serotonin Reuptake Inhibitors (SSRIs), Serotonin Norepinephrine Reuptake Inhibitors (SNRIs), and Tricyclic Antidepressants (TCAs), among many others, which each have their disadvantages. There is a certain subpopulation of individuals who do not respond to any of these drugs or struggle to afford them. This present experiment sought to identify a novel, herbal treatment for MDD without such drawbacks using extracts of two plants: *Withania somnifera* (WS) and *Griffonia simplicifolia* (GS). Both extracts were tested on *C. elegans*. A wild isolate called N2 as well as the AQ866 knockout mutant, which is deficient in a protein that is similar to the human 5-HT receptor 1A (5-HT1AR), were used. This deficiency has been linked to MDD. The herbal extract treatments were administered with the nematodes' food and its efficacy was measured by its ability to support reproduction rates and heat-stress resistance. It was observed that 1 mg/mL of 5-hydroxytryptophan (5-HTP) (the seed extract of GS, and precursor to 5-HT) and 3 mg/mL of KSM-66 (the root extract of WS) had the highest rate of reproduction and post-heat-stress survival for the knockout mutant, where a Chi-square was conducted and $p < 0.0001$. The increased reproduction rates and stress resistance suggest that combining the two treatments may be a promising potential treatment for MDD.

Keywords: Major Depressive Disorder, Caenorhabditis elegans, KSM-66, 5-Hydroxytryptophan

[32] Evaluating the Bioremediation Potential of *Bacillus Licheniformis* as a Novel Method for the Passive Treatment of Acid Mine Drainage (AMD)

Noah Campbell | Oak Park and River Forest High School

Acid mining drainage (AMD) waste, a byproduct of mining and bioleaching operations, poses a severe environmental threat due to its high acidity and toxic metal content. Current AMD treatment methods are costly and inadequate. This experiment explored *Bacillus licheniformis* as a potential AMD bioremediation agent. Its versatility in oxygen environments, sulfur reduction capabilities, and wide pH tolerance (3.0-9.0) make it an ideal candidate for addressing AMD hazards. This experiment tested the ability of *B. licheniformis* to raise the pH of a simulated AMD solution and grow its population. Parameters included the pH and absorbance of visible light at 600 nm (measured via Vernier SpectroVis spectrophotometer compared to a standard curve). Final pH values were recorded after a 24-hour treatment period, and final absorbance values were taken after a 48-hour period to calculate its change. Each of the experimental groups resulted in a substantial increase in pH in several Welch's two-tailed t-tests, compared to the control showing statistical significance ($p < 0.0001$). These findings suggest that *B. licheniformis* can potentially be used as an effective treatment method for AMD.

Keywords: B. licheniformis, acid mining drainage (AMD), bioremediation, sulfur-reducing bacteria, increasing pH

[34] Frobenius discriminants

Bogdan Jones | Walter Payton College Preparatory High School

Purpose: Elliptic curves play a central role in modern number theory. One problem of interest is to study the arithmetic of the Frobenius discriminant $a_p(E)^2 - 4p$ associated to an elliptic curve E and a prime p. On the theoretical side, David and Jiménez Urroz investigated the squarefreeness of this integer. On the applied side, Rostovtsev and Stolbunov proposed a cryptographic protocol that requires a large prime factor of this integer. This project investigates whether, given a random elliptic curve, there exist infinitely many primes p for which the Frobenius discriminant is divisible by a large prime.

Procedure: The procedure is rooted in the normal order method of Turán from 1934, refined and adapted to elliptic curves by Murty and Murty in 1984. The method of Murty and Murty is refined further to the theoretical study of the large prime factors of $a_p(E)^2 - 4p$. Furthermore, the computer software MAGMA is used to numerically investigate the prime factors of the Frobenius discriminants.

Conclusion: It is shown that, for a generic elliptic curve E and for a natural density 1 of primes p, the largest prime factor of $a_p(E)^2 - 4p$ is greater than $\frac{1}{p\sqrt{\log p}}$. This result is proven theoretically assuming a generalized Riemann Hypothesis. It is also verified numerically, independently of this assumption, that the result holds for 11 elliptic curves and all primes up to 10^7 except for at most 0.025% of them.

Keywords: Prime numbers, elliptic curves, cryptography

[36] H20btainer; A Water Harvester Device Controlled by Metal Organic Frameworks

Akshitha Sushil | Adlai E. Stevenson High School

Purpose: Water assists in many functions & practically provides in all of its components. Thus, maintaining the amount of water necessary is essential. The 'H20btainer' was invented to elaborate the importance of water stabilization & to blossom innovative ways to retain water, while sustaining environmental protection & money for people risking lives by considering water term(s). The project is partly presented to illustrate other's to consider water harvesting a crucial aspect for the future. A certain class of acute porous materials termed 'Metal Organic Frameworks', have formed & they are strictly capable of collecting water molecules. The individual particles or particles of water fixtate between the small microscopic pores (created from open surface areas). When substances travel through structures of pores in the expanse; the M.O.F. relieves impurities, & releases amounts of moisture to be condensed to water. This H20btainer prototype is planned to use Passive Radiative Cooling & Relative Humidity by exposing the device to the sky through the dayti1ne to absorb moisture using the M.O.F; although, during the night the device will radiate heat to outer space, & occupy the cooler air outside, soon saturating the moisture. pH levels measure the amount of hydrogen ions in the water, basing it more acidic or alkaline; by testing the quality of the water, it's possible to test efficiency (with volume). **Conclusion:** The water harvester was more successful than I could have imagined, the system went above & beyond my expectations & met all criteria requirements tested for in the investigation(s).

Keywords: Water-Harvestation, Metal-Organic-Frameworks, Relative-Humidity, Passive-Radiative-Cooling

[38] Implementing Model-Based Water Quality Testing Using AI Parameter Reduction
Ishika Mathur and Zainab Petiwala | Adlai E. Stevenson High School

Study Objective/Purpose: Create an inexpensive water quality testing device with a reduced set of sensors that correspond to a reduced set of parameters after implementing dimensionality reduction using AI.
Procedure: 1. Collect water quality data from U.S. states from US EPA website 2. Clean, filter, and label all the data into categories through a python scripting code 3. Remove outliers from the data and create statistical plots for analysis 4. Prepare the data for machine learning and run the LazyPredict algorithm to find the most accurate model 5. Split the data using the 80-20 model and train the Decision Tree Classifier model with 80% of the data 6. Use the 20% data to predict water quality and analyze accuracy and error 7. Implement parameter reduction by removing one parameter at a time and observe changes in accuracy and error 8. Collect sensors for all the remaining parameters after parameter reduction 9. Connect and code all the sensors with Raspberry Pi 10. Test the device in water samples and make sure results are accurate.
Results & Explanation: We were able to find a model with high accuracy called Decision Tree Classifier model to implement dimensionality reduction. We reduced the original set of 10 parameters to 6 parameters, while keeping the accuracy at 95% similarity to the original. We were able to successfully create a water quality testing device using a reduced number of sensors that efficiently, accurately, and inexpensively predicted water quality in a sample as either potable, usable, or not-usable.

Keywords: Machine Learning, Water Quality, Water, Design, Device

[40] Magnetic Field Effect on Plant Height, Mass and Sprouting in Microgravity
Shraddha Karpoor | Adlai E. Stevenson High School

This experiment was conducted to determine the effect of different magnetic field strengths on plant height, mass, and time it takes for speckled pea plants to sprout in microgravity. To conduct this experiment, there were three experimental groups with different magnetic field strengths in pots with five speckled pea plant seeds. A clinostat was created in order to simulate microgravity conditions so the three pots would be mounted onto it and rotated at 40 rpm with a radius of 0.55 meters (simulating 1.44% of the gravitational field on Earth). The hypothesis is supported in this experiment as it is revealed that as the magnetic field strength increases in microgravity, the plant's height and mass also increase (strongest magnetic field: 23.5 inches as the tallest height and 1.27 g as the average mass vs no added magnetic field: 18 cm as the tallest height and 0.69 g as the average mass) and the plants sprout quicker (days 4, 5, and 6 for strong magnetic field, and days 7, 10, and 14 for no added magnetic field). Thus, the stronger the magnetic field, the greater the height, mass, and quickness of a plant to sprout in microgravity, supporting the initial hypothesis. There may be several explanations for this; one being that a stronger magnetic field increases plant function and growth due to its increase in energy. Therefore, once stronger magnetic fields are applied to the plants in microgravity conditions, the plants naturally grow at a greater rate.

Keywords: Plant, microgravity, magnetic field, height, mass

[42] Mathematical Modeling of the Optimal Light Wavelength for Increasing Biomass and Cell Size of Chlorella vulgaris as a Basis for Enhancing Biofuel Production

Sidharth Brahmandam | IMSA/RISE

The pressing need for eco-friendly fuel sources due to limited fossil fuels and rising population has brought attention to microalgae such as *Chlorella vulgaris* (*C. vulgaris*) as a sustainable biofuel. Yet, high production costs hinder their commercial viability, which can be addressed by optimized lighting. However, a gap exists concerning the optimal wavelength of light to enhance biomass growth and cell size in *C. vulgaris*. This experiment investigated the impact of varying light wavelengths (400-650 nm) on biomass growth and cell size to develop a predictive mathematical model aimed at increasing the productivity of commercial units. In this experiment, separate containers were established for four groups that were each exposed to different light wavelengths: Blue (400-490 nm), green (510-530 nm), red (630-650 nm), and control (no light), and a 12hr:12hr light-dark cycle was used. Biomass concentration was measured using a spectrophotometer over 10 days and the data for each condition was regression fitted to a logistic growth curve. The cell size was measured on the last day using a light microscope. The results indicated that *C. vulgaris* exposed to blue light (400-490 nm) had the largest positive change in biomass, followed by red (630-650 nm) and green (510-530 nm). *C. vulgaris* exposed to red light had significantly smaller cell sizes, while other groups had comparably larger cell sizes. The derived mathematical model can be extrapolated to large-scale plants. Overall, the null hypothesis can be rejected, as $p < 0.001$. This has implications for reducing the cultivating and harvesting costs *of C. vulgaris*.

Keywords: Microalgae, Chlorella vulgaris, Light Emitting Diodes, Biomass, Growth Kinetics

[44] Modeling Two-Dimensional Celestial Motion Using Epitrochoids

Nikhil Gangavarapu | Adlai E. Stevenson High School

The purpose of this study is to explore practical applications of mathematical concepts to design a model depicting planetary orbits using epitrochoidal shapes in order to pique the interests of high school students. Equations were created to model the motion of one smaller, rotating spirograph around a larger, stationary spirograph. Then the equations were applied to planet and satellite pairings, and input into Desmos to draw the shape and find orbit diameters, using actual distances to confirm the accuracy of the model through a percent error test. The initial results displayed percent errors of less than 5%, however, they were false positives due to only accounting for circular, rather than elliptical orbits. Thus, the equations were then redesigned to account for eccentricity to accurately represent celestial orbits' elliptical nature. After the redesign, instead of only finding the orbit diameter of satellites as one value, the minor and major foci were calculated, resulting in accurate minimum, maximum, and average, orbit diameters, all with less than 5% percent error. Therefore, the model proved to be accurate in using epitrochoidal shapes to model orbital diameters of planet and satellite pairings. By modeling a vast concept such as celestial motion using trigonometry, high school students begin to understand that the topics they learn in their classes truly have a purpose that extends beyond just the classroom.

Keywords: Celestial motion, epitrochoids, trigonometry, Orbit diameters

[46] Novel Treatment as Reduction of Oxidative Stress Using Mixed Antioxidants for Alzheimer's Disease Symptoms
Sahana Garapati | IMSA/RISE

The purpose of this research was to investigate if the combination of the antioxidants ferulic acid, curcumin, and caffeine decreased oxidative stress (OS) in order to ascertain if mixed antioxidants facilitate a greater decrease of AD symptoms due to the correlation between OS and AD symptoms that have been established through previous research. Determining novel therapeutics for AD is especially important because current treatments are expensive and have low success rates with undesirable side effects. A potential novel treatment based on this experiment may address the current gap in AD treatment. The procedure of the experiment began with concentrating individual antioxidants into nematode growth medium to form the positive control group's petri dishes, along with a negative control group with no antioxidants. Then, synchronized, genetically modified adult CL2166 *C. elegans* worms were placed onto the control plates and were observed for a week by taking pictures under fluorescent light. This process was repeated for mixed chemical plates then analyzed at the end of data collection. Overall, it was determined that the novel mixture of caffeine and FA as well as curcumin and FA decreased OS therefore rejecting the null hypothesis. The one-way ANOVA p value was below 0.0001 and individual t-tests conducted concluded significant values at (p<0.05) for the groups caffeine with FA and curcumin with FA, supporting that these treatments were effective at reducing OS. With future research it is likely that a novel pharmacotherapeutic treatment may be produced that is accessible, effective, and inexpensive.

Keywords: Antioxidants, Alzheimer's disease, Caffeine, Ferulic Acid, Curcumin

[48] Novel Use of an Economic Projection Model For the Purpose of Assessing the Socioeconomic Impact of the Pretrial Fairness Act on Cook County Neighborhoods
Bella Lubelchek | Oak Park and River Forest High School

In September 2023, the Pretrial Fairness Act was passed in the state of Illinois. As a result, the burden of cash bail payment was removed, allowing individuals who would otherwise not have been able to afford bail to be released from pretrial detention. This unprecedented shift in policy has the potential to greatly impact the financial situation of arrested individuals, particularly those who were low-income going into their arrest. This economic projection aimed to assess the long-term financial impacts of the Pretrial Fairness Act in Cook County, Illinois' largest county. After analyzing declassified data from the Cook County Sheriff's Department as well as open-source Cook County and Census Bureau data using RStudio, the 5-year change in financial situation was assessed through the novel usage of an economic projection model. This projection demonstrated the possibility of more than an $8.9 billion increase in funds within the whole of Cook County over the 5-year period between 2022 and 2027, taking into account both the increase in funds from bail and the provision of a steady income (t-test p-value <0.0001). This result indicates both the applicability of the model and the fact that the Pretrial Fairness Act has the ability to create great economic gains for those most directly impacted, including low-income and Black and Brown individuals. Future research is needed to determine the additional support necessary.

Keywords: Pretrial detention, bail reform, socioeconomic situation, financial impact, Cook County

[50] On-Campus Wetland-Based Solutions to Pollutants
Lilianna Daniel and Shirley Zhuang | Oswego East High School

Abstract not provided.

Keywords: Wetland, pollution filtration, nutrient uptake, ecosystem

[52] Optimizing Bioremediation of Lead (II) in Wastewater with *Lactobacillus acidophilus* and Chitosan Across Variable pH
Sahiba Dhillon | Oak Park and River Forest High School

The presence of lead ions in wastewater is a growing concern worldwide, but especially in impoverished communities, where approximately one-third of children have elevated lead levels in their bloodstream. The current remediation techniques are expensive, inefficient, and inaccessible to regions that require quick and dependable removal of toxins from water, particularly those economically challenged communities. Novel filtration techniques have been investigated, including one involving lactic acid bacteria (LAB) ubiquitous in living organisms, ranging from dairy products to the human gut. LAB carries a negative charge, facilitating metal ion binding due to the positive charge of Pb (II). This experiment aimed to examine the interaction between the specific LAB, *Lactobacillus acidophilus* (*L. acidophilus*), and chitosan at varying pH levels of lead (II) contaminated wastewater. The hypothesis asserted that the addition of d-glucosamines, such as chitosan, and the manipulation of the acidity of the solution could enhance the negative charge, thereby increasing the absorption of lead. The results of this experiment demonstrated that while both *L. acidophilus* and chitosan exhibited absorbent properties individually, the combination of *L. acidophilus* and chitosan was more effective in absorbing lead in almost all groups tested (ANOVA $p < .001$), and that their synergy was enhanced the most in basic environments. Therefore, the null hypothesis was rejected. These findings have promising implications for larger-scale wastewater purification, particularly in communities that do not have access to standard lead removal techniques due to economic constraints.

Keywords: lactic acid bacteria, Lactobacillus acidophilus, biosorption, lead, chitosan

[54] Quantification of the Effects of Diluted Bitumen Oiled Substrate on Germination Rate, Size, Mass, Chlorophyll and Hydrogen Peroxide Content of the Keystone Species *Zizania palustris*, With Implications for Pipeline Risk Assessment
Katherine Stabb | Oak Park and River Forest High School

Diluted bitumen (dilbit) is an unconventional oil product produced from tar sands, including those in Canada. Unlike conventional oil, dilbit tends to sink when spilled, potentially remaining in the sediment for years after contamination. However, relatively little is known about dilbit's effects compared to more conventional crude oil products. Specifically, no studies to date have quantified the specific impacts of diluted bitumen oiled sediment on freshwater macrophytes, such as wild rice (*Zizania* spp.). This plant is ecologically and culturally important, native to the Midwest and Canada, and at high risk in the case of a dilbit spill. In this experiment, *Zizania palustris* plants grown in sediment with varying concentrations of dilbit were analyzed for their germination rate, size, mass, chlorophyll and hydrogen peroxide content. High dilbit exposure (8%) was associated with a decrease in the shoot height (adjusted $p = .0007$, Games-Howell post-hoc test), root length ($p < .0001$), and shoot and root fresh mass ($p = .0035$ and $p = .0296$ respectively) of *Z. palustris* plants over 23 days. This finding suggests that although wild rice plants may be resilient to lower dilbit concentrations, higher concentrations risk damaging the health and success of the plants. By providing concrete information on dilbit's toxicity, the results of this experiment have the potential to inform risk assessment before building pipelines or other tar sand oil infrastructure, especially in areas with native wild rice growth.

Keywords: Diluted bitumen (dilbit), tar sands, Zizania palustris, ecological risk assessment, polycyclic aromatic hydrocarbon (PAH)

[56] Quantifying Microplastics in Medicine Vials Through Fluorescent Microscopy: A Risk Assessment
Abdullah Mohammed | IMSA/RISE

The purpose of this experiment was to investigate the number of microplastics found in medicine bottles of popular brands. Previous studies have indicated that microplastics can be found in many plastic products (i.e. water bottles, milk cartons, juice cartons, etc.) and have been shown to contain hundreds to thousands of microplastics per sample. The findings of this experiment highlight a potential problem that may impact billions of people globally and serve as a basis for future risk assessment research and how microplastics relate to medicinal efficiency. 90 medicine bottles were collected and stored on an oscillator for 1 day. These bottles contained water of 90°C-100°C, they were cleansed previously with 10 mL of 30% hydrogen peroxide and distilled water (DI water). They were then filtered using a borosilicate glass filter using a vacuum filtration system and each filter was placed into Petri dishes organized by brand. During filtration, they were doused with 5 mL of a fluorescein solution and left to dry for 15 minutes in the Petri dishes. Finally, they were placed on glass slides into the fluorescent microscope at 4000x zoom. All microplastics found in the images were quantified by hand and organized by totals per sample. Overall, the findings demonstrate the rejection of the null hypothesis(H0) as exemplified in the Table 2 t-tests. The lowest p-value found in the t-tests was from Spirit and Advance comparison ($p<.004$), and the highest p-value found was ($p<.999$) from multiple comparisons.

Keywords: Medicine, Bottles, Fluorescent, Microscope, Microplastics

[58] Species Distribution Model of Predicted Populations of *Acropora clathrata* in the John Brewer Reef Under Forecasted Oceanic Conditions to Establish the Threat of Climate Change on Keystone Coral Species
Elora Cianciolo | Oak Park and River Forest High School

Rising sea surface temperatures (SSTs) as a result of climate change are increasing coral bleaching rates across the world. Coral are essential to the marine ecosystem, providing food and shelter to thousands of organisms. Although climate change has resulted in more frequent bleaching events and higher mortality rates in coral, how changing SSTs impact specific locations and species is unknown. Currently, researchers are investigating the impact of SSTs on coral survival and establishment of primarily endangered species in order to develop effective conservation strategies. These studies traditionally abstain from applying their findings to location-specific scenarios which could result in generalization of the environmental situations, therefore creating a gap and a need for a novel procedure. In this experiment a species distribution model of *Acropora clathrata* in the John Brewer Reef (JBR) in Australia was created under forecasted SSTs for the years 2030, 2050, and 2100 as to ascertain the threat of climate change on keystone coral species and to establish a novel procedure for predicting potential coral survival. In addition to statistically analyzing the correlation of DHWs and SSTs, this experiment compiled SST data on a bathymetric map of the JBR in order to communicate the findings more effectively in a series of five visual models. It was discovered that SSTs could reach 33℃ in 2100, exceeding the temperature threshold which *A. clathrata* could survive in, indicating that JBR would become uninhabitable for *A. clathrata*. To increase the validity of these findings, further research involving more real-world conditions is needed.

Keywords: Sea surface temperature (SST), John Brewer Reef (JBR), Acropora clathrata, climate change, coral bleaching

[60] Study of Microplastic Data In Rivers Concerning Local Population Size

Samarth Donapati and Arav Kesaria | Adlai E. Stevenson High School

Purpose: This study aims to investigate the presence of microplastics in rivers and to explore whether there is a connection between the types of microplastics found in these rivers and the population size of the nearest city. While examining these different rivers, we hope to shed light on how the shapes of the microplastics are influenced.
Procedure: The researchers had a computer with internet access. They converted data files of reported levels of microplastics present in rivers into an xlsx format. Unnecessary columns were deleted, particle ranges were put into common units, and particle ranges were sectioned into >1000 and <1000. They found the population of the nearest city near the river and included it. Finally, they categorized the cities into their correct population size ranges.
Conclusion: When we look at the data for the small population size range, we can see that fibers/lines are the most present microplastics. Something unexpected we noticed within our project was the jump in variety between the small and medium population size ranges. In the small population size range, there were mostly only fragments and lines present, and wasn't a lot of variety. However, in the medium population size range it showed a more variety with the microplastics. Finally, when we look at the microplastic size range in the rivers, the range “less than 1000mm” was in almost every case the range that had a larger number of microplastics.

Keywords: Microplastics, Rivers, Population, Shape, Size

[62] The Degradation of Polyvinyl Acetate Using *Candida rugosa*: A Novel Method to Remove Discarded Chewing gum on Concrete

Rachel Sang | Oak Park and River Forest High School

The improper disposal of discarded chewing gum (cuds) has led to immense challenges as thousands of nonbiodegradable black cuds infiltrate sidewalks, persisting for 90-100 years. Current methods to remove discarded gum from concrete include blowing chemicals onto the cud, power washing, and scraping it off by hand. These methods are time-consuming, costly, and negatively impact the environment. As the popularity of chewing gum rapidly increases, these problems are magnified. A potential method to remove the cuds is using lipases that have been used to degrade certain plastics, including *Candida rugosa* (CRL) lipase. The purpose of this experiment was to find a time-efficient and environmentally friendly method. This experiment contained four groups that used a novel method to model gum cuds on sidewalks using concrete bricks. The negative control soaked the cuds in 21°C tap water and the positive control used acetone (>99% pure). The two experimental groups were conducted with varying concentrations of CRL. It was hypothesized that at a greater concentration, the lipase solution would remove the gum cuds with greater efficiency because as the concentration increases, its activity proportionally increases. A photometric analysis was done using Adobe Photoshop to compare the gum cud’s surface area before and after treatment where percentages were calculated. The high concentration had high removability (ANOVA $p < .0001$), demonstrating a statistically significant result in removing the adhesions from chewing gum that allowed for the rejection of the null hypothesis. To validate these findings, future research should be done in a real-world application.

Keywords: Chewing gum, Candida rugosa, removal, adhesion mechanism, photometric analysis

[64] The Effects of Selected Lanthanide Nitrate Salts on the Viability and Morphology of the Protozoan Parasite *Leishmania tarentolae*

Joshitha Bodavula | University High School at Illinois State University

Leishmaniasis is an often deadly disease characterized by both cutaneous and visceral infections, and it is caused by the protozoan parasite, *Leishmania*. More than 80 countries report these infections for which there are few good drug therapies. The goal of this research is to investigate the effects of selected lanthanide nitrate salts on the viability and morphology of *Leishmania tarentolae*, a species of Leishmania that is not infectious to humans but is used as a model system. In this experiment, six cultures were created: BHI growth medium only, BHI with cells (control) but with no other additions, $NaNO_3$ with cells (second control), Ytterbium (Yb) with cells, Erbium (Er) with cells, and Lanthanum (La) with cells. Lanthanides were used due to their critical roles in the modern electronics and chemical industries. Using the methods of light microscopy and MTT (viability) spectrophotometric assays, both qualitative and quantitative data were collected on the growth, behavior, and shape of the cells. The control groups showed no significant changes to cell growth, whereas the cultures with addition of lanthanides showed signs of increased cell activity. La, in particular, had shown a notable increase of cell growth which can be seen through both microscopy and the MTT viability results with a 138% increase relative to control cells. These results indicate that La may have a positive effect on the growth of Leishmania which could have serious implications on infectivity rate globally, especially when overlap of La mining and extraction occurs alongside presence of the leishmania parasite.

Keywords: Leishmania tarentolae, Lanthanide nitrate salts (Yb, Er, La), Light microscopy, MTT (viability) spectrophotometric assays

[66] The Impact of Sodium Hypochlorite and 2-Propanol on the Quantity of DNA Extracted from Human Fingerprints for the Advancement of Forensic Fingerprinting Technologies

Margaret McIntyre | IMSA/RISE

Fingerprints are frequently used as evidence in forensic investigations. However, fingerprint evidence is often chemically tampered with. The purpose of this experiment was to determine the individual impact that two chemicals: sodium hypochlorite and isopropyl alcohol have on the DNA that can be successfully extracted from a fingerprint. The results collected from this research can inform the advancement of fingerprinting technologies. Fingerprints were taken on sterile pieces of filter paper and individually treated with 5 microliters of 5% concentration bleach and 99% concentration isopropyl alcohol. The DNA was extracted from each piece of filter paper and quantified in nanograms using qPCR. A negative control group with no DNA and a positive control group were utilized along with two positive control treatments. It was determined that sodium hypochlorite and 2-propanol decrease the amount of DNA found in fingerprint samples. t-tests revealed that sodium hypochlorite (p <0.0001) and 2-propanol (p <0.0001) contained significantly lower amounts of DNA than the negative control treatment, rejecting the null hypothesis. The data from this experiment may serve as a basis for future research in order to optimize forensic technologies.

Keywords: Sodium hypochlorite, 2-propanol, qPCR, fingerprints, DNA

[68] The Speed of Light

Vanshika Bandaro, Shloka Chebolu, and Mahesi Annapragada | Chiddix Junior High School

Since Galileo's time, calculating the speed of light has posed a formidable challenge, captivating some of history's greatest minds. In this study, we delve into the classical methodologies employed to determine this fundamental constant. Additionally, we investigate the wave nature of light, leveraging microwaves as a tool to estimate the speed of light. Through these explorations, we gain insight into both the historical approaches and modern techniques used to unravel the mysteries of light's velocity.

Keywords: Galileo, Moons of Jupiter, Ole Roemer, Retro Reflector

[70] The Use of Croton and White Oak Bark Extracts on a *Bombyx mori* Model as the Basis for Novel Pharmacologic Agent to Treat Hyperglycemia

Abby Falkoff | Oak Park and River Forest High School

Hyperglycemia is one of the largest problems that impacts individuals suffering from type 2 diabetes mellitus (T2DM). Chronic hyperglycemia contributes to serious health problems, such as vision loss, sleep apnea, skin contusions, nerve damage, heart, kidney and cardiovascular diseases. There are several treatments currently used for controlling hyperglycemia in T2DM patients; however they often have severe side effects and are inaccessible to a large population, due to their high costs and inability to be obtained in remote areas. This experiment modeled hyperglycemic induced *Bombyx mori* (silkworms) and tested the effects of hypoglycemic effects of croton and white oak extracts. Hyperglycemic conditions were induced using a high glucose diet over an 18-hour time frame. Croton and white oak extract injections of varying doses were then administered. The effectiveness of croton and white oak extracts was evaluated with respect to hemolymph glucose levels. The results showed a statistically significant reduction (*p*-value of 0.0111) in glucose levels associated with the administration of 0.04 ml of white oak after 90 minutes. This experiment therefore provides support for the potential effectiveness of white oak—though not of croton or a combination of croton and white oak—as a less-expensive and more-accessible medication to treat T2DM.

Keywords: Hyperglycemia, type 2 diabetes mellitus, croton extract, white oak extract, silkworm diabetic model

[72] Unveiling the Correlation Between Temperature Fluctuations and VOC Emissions in Peppermint: Exploring the Influence of Varying Temperatures on VOC Release

Jiya Jain | IMSA/RISE

Purpose: This experiment aimed to explore how temperature fluctuations impact the emission and reception of chemical signals in peppermint plants, providing insights into their communication dynamics. By investigating the influence of varying temperatures on the release of volatile organic compounds (VOCs), the study contributes valuable information to understanding plant communication and ecological interactions, with potential applications in agriculture for crop management.
Procedure: The controlled experiment involved individual containers for each plant, maintaining uniform environmental conditions. Peppermint plants were grouped by specific temperature ranges, and heaters or coolers regulated the temperatures. VOC emissions, plant growth, and communication or stress indicators were monitored, ensuring a comprehensive analysis.

Conclusion: The investigation revealed significant variations in aroma intensity, signaling compounds, and communication behaviors among peppermint samples, strongly influenced by specific temperature conditions. This emphasizes the importance of considering environmental factors in comprehending plant interactions. The statistical analysis, utilizing an ANOVA test, showed an overall non-significant *p*-value of 0.8574, indicating that observed differences were likely due to random variability rather than temperature effects.

Keywords: Methanol, Peppermint, Volatile Organic Compounds (VOCs), Temperature, Signaling

[74] Using Techniques Similar to Anti-Aliasing and Geometry Shaders to Omptmize Voxels
Sheldon Huynh C | Niles West High School

This project is about optimizing the rendering of voxels that are used in specific situations with volumetric data. They can also be used to add or subtract geometry in a simple way. Two different optimizations are explored. One of them is to use a technique similar to anti-aliasing in order to create semi-transparent voxels that will create an illusion of a curved edge. The other is to offload some of the rendering to the Graphical Processing Unit (GPU), which is faster because it can do parallel tasks, by utilizing a geometry shader. There was an error when comparing the images with each other to measure accuracy, but based on qualitative observations, the anti-aliasing solution does work in specific situations and has an added bonus of having more realistic lighting. The geometry shader solution does work very well compared to not using the GPU to create the cubes even if it was made while loading the voxels. These solutions optimize the rendering of voxels, but there needs to be more work done on them in order for them to be used in more broad circumstances.

Keywords: OpenGL, c++, Voxel, Optimize, 3D

[76] Vermicomposting: A Path Towards Organic Fertilizers
Paul Bramstedt | Oswego East High School

This study investigates the effectiveness of vermicompost as a soil amendment for the growth of garden sorrel. The hypothesis is that vermicompost will demonstrate higher nutrient values and better promote plant growth compared to local soils. Two composting bins were established to provide the volume of vermicompost needed. Garden sorrel was grown from seed in local soils, with one pot serving as a control and the other dosed with compost. Results showed that the plant treated with compost consistently exhibited higher soil moisture content and a steeper growth slope compared to the control. Soil testing kits revealed higher levels of potassium and nitrite nitrogen in the vermicompost. Additionally, the vermicompost showed visibly higher levels of humus, which positively impacted plant growth. This study provides valuable insights into how we can use vermicompost as a soil amendment to benefit plant growth.

Keywords: Vermicomposting, Composting, Soil Additives, Nutrients

Poster Session II - Abstracts

[1] Comparative Analysis of CNNs for Classifying Alzheimer's Disease
Shrihan Tummala and Debarghya Roy | Adlai E. Stevenson High School

Purpose: The purpose of this experiment is to determine the ability of convolutional neural networks in detecting the various stages of Alzheimer's disease. As the number of people with Alzheimer's increases, so does the need for better diagnostic tools which this research helps delve further into by identifying the strengths and weaknesses of different CNNs in detecting the disease.
Procedure: The classes in the dataset were severely imbalanced so modifications were applied to set all classes to an equal size of 5000. After preprocessing the dataset, several tensorflow libraries that contained the CNN models along with the balanced dataset were imported to a Kaggle Notebook. Then, the dataset was split into a 70:10:20 ratio where 70% of the data is used for training, 10% for validation, and 20% for testing. Finally, we trained and tested every single model and recorded their testing accuracy for comparison.
Results: VGG16 had the highest accuracy at 94.83% accuracy and was closely followed by ResNet50 and DenseNet169, which achieved accuracies of 93.60% and 92.72% respectively. However, Xception fell behind with an accuracy of 90.45%.
Conclusion: The hypothesis was supported because the VGG16 performed with the highest accuracy out of all four CNNs. This is likely due to its architecture which allows the network to analyze complex patterns while mitigating overfitting. Additionally, VGG16 also introduced the concept of adding layers to increase accuracy. However, all four CNNs attained an accuracy of over 90%, reinforcing their reliability in identifying Alzheimer's Disease.

Keywords: Convolutional Neural Network, Alzheimer's, MRI, Artificial Intelligence, Image Classification

[3] Aminoglycoside Synergy for Novel Combination Therapy for the Treatment of Multidrug-Resistant Infections
Danaan Perry | Oak Park and River Forest High School

Multidrug-resistant infections are an omnipresent challenge in the clinical treatment of bacterial infections that kill hundreds of thousands of people every year in the United States alone. In particular, multidrug-resistant tuberculosis (MDR-TB) is on the rise. 1.3 million people died of tuberculosis in 2022 and tuberculosis was the second greatest infectious killer worldwide after COVID-19. Resistant infections are treated with a wide array of antibiotics. One class of antibiotic used in the treatment of bacterial infections is the broad-spectrum aminoglycosides (AMG); AMGs prevent cell growth by inhibiting protein synthesis. More effective ways to use these existing antibiotics, such as synergy, where two drugs in combination have amplified effects, have been explored for potential combination therapies. However, this research has been done primarily with different classes of antibiotics. This experiment examined the potential synergistic effects of several subclasses of AMGs in combination. In this experiment, the minimum inhibitory concentration (MIC), or lowest concentration that prevents cell growth, was determined for four AMGs. Checkerboard assays were conducted to be used in a fractional inhibitory concentration (FIC) equation. The MIC and checkerboard assays resulted in *p*-values less than the determined alpha value of 0.05, meaning the data was statistically significant. The calculated FIC values obtained in this experiment suggested that the tested combinations of AMGs were additive, ranging from 0.5 to 1. Thus, this experiment could not conclusively determine synergistic effects among AMGs. However, the findings demonstrate that there is potential for synergy and further research is suggested.

Keywords: Multi-drug resistant infections, minimum inhibitory concentration (MIC), fractional inhibitory concentration (FIC), synergy, aminoglycosides

[5] Analyzing the Impact of Gabapentin on GBM-Modeling *C. elegans*

Jonathan Nguyen | Niles West High School

Purpose: The purpose of this experiment is to determine whether gabapentin can be used as a treatment for glioblastoma multiforme (GBM).
Procedure: Two strains of *C. elegans* were selected to model glioblastoma multiforme (GBM). The mutations that cause GBM cause different mutations in *C. elegans*. The *MT2124* strain has the multivulva (Muv) phenotype, in which small masses are found on *C. elegans*. The *BS3164* strain becomes infertile due to the mutation, which reduces the number of hatched eggs. The *C. elegans* were chunked onto petri dishes with gabapentin-treated agar. Over time, measurements were conducted to determine the effect of gabapentin. For *MT2124*, the percentage of *C. elegans* with Muv was calculated; if the percentage of Muv decreases, gabapentin is effective. For *BS3164*, the percentage of hatched eggs was calculated; if the percentage of hatched eggs increases, gabapentin is effective.
Conclusion: The hypothesis for this experiment predicts that if *MT2124* Muv phenotype *C. elegans* are exposed to gabapentin, then over time, the percentage of Muv phenotype *C. elegans* will decrease. Over the course of several trials, the experimental groups with the highest concentrations of gabapentin displayed the lowest average percentage of Muv phenotype and the lowest rate of growth of Muv phenotype. This supports the hypothesis that gabapentin is able to reduce the THBS1 mutations that cause GBMs to grow, since the mutation becomes less expressed. Further investigations will utilize the *BS3164* strain of *C. elegans* to determine how gabapentin affects mutations of the Notch signaling pathway, which also contributes to GBM growth.

Keywords: brain cancer, gabapentin, chemotherapy, mutation, glioblastoma multiforme

[7] Caveolin-1 Dephosphorylation-dependent Upregulation of Desmosomal Proteins by Kv11.1 Activator NS1643

Jaden Blankenship | Illinois Mathematics and Science Academy

The primary objective of cancer therapy is the prevention of metastasis, a process involving the dissemination of cancer cells to distant organs. Breast cancer metastasis is critically dependent on caveolin-1 (Cav-1) expression and phosphorylation by promoting cell migration. Interestingly, human triple-negative breast cancer cells (MDA 231) uniquely overexpress the K+ channel Kv11.1, providing a potential drug target not present in normal breast epithelia. In a recent study, the Minshall lab showed that treatment of MDA 231 cells with Kv11.1 K+ channel activator NS1643 induced the dephosphorylation of Cav-1 and resultant dissociation of β-catenin, a crucial regulatory protein for assembly of cell-cell adhesion complexes. Further, NS1643 led to enhanced interaction, assessed by immunoprecipitation and untargeted proteomic analysis, of β-catenin with adherens junction protein R-cadherin, focal adhesion proteins paxillin, vinculin, and FAK, and desmosomal proteins desmoplakin, desmoglein, and plakophilin. These results suggest NS1643-induced β-catenin relocalization to cell-cell junctions may enhance adhesion and thereby reduce cell migration and metastasis. To begin to test the idea that NS1643 promotes cell adhesions, we treated MDA 231 cells for up to 24 hrs and conducted Western blot analysis of phospho-caveolin-1, desmoplakin, desmoglein, and plakophilin proteins, and also measured electrical resistance of cell monolayers grown on gold-plated microelectrodes with an epithelial cell impedance system. Results thus far indicate NS1643 rapidly reduces caveolin-1 phosphorylation and increases the expression of desmosomal proteins as well as monolayer resistance within 24 hrs. Thus, this study is beginning to reveal a potentially promising pharmacological mechanism for inhibiting breast cancer metastasis by promoting Cav-1 dephosphorylation-dependent increase in β-catenin supported cell-cell desmosome adhesions.

Keywords: Cells, Breast cancer, desmosomes, proteins, B-catenin

[9] Comparing the antibacterial effects of star anise and oregano essential oils against *S. epidermidis* and *E. coli*
Adil Shamsudeen | Adlai E. Stevenson High School

Purpose: This study aimed to determine the antibacterial effects of star anise essential oil, oregano essential oil, and the antibiotic Tetracycline against *Staphylococcus epidermidis* (Gram-positive) and *Escherichia coli* (Gram-negative) bacteria. The objective was to demonstrate the potential antimicrobial properties of the essential oils, and compare their efficacy with an antibiotic, across Gram-positive and Gram-negative bacteria.
Procedure: An agar disc diffusion assay was performed. Nutrient agar plates were inoculated with *E. coli* or *S. epidermidis* via streak plating. Discs infused with Tetracycline, oregano oil, star anise oil, and canola oil (negative control) were placed on the plates. After incubating at 37°C for 72 hours, the zones of inhibition around each disc were measured, with larger zones indicating better antibacterial efficacy. Ten plates were tested per bacterium.
Conclusion: The hypothesis was partially supported. Oregano oil exhibited significantly higher efficacy than star anise oil and Tetracycline against both bacteria (p<0.0001). However, no significant difference in susceptibility between Gram-positive and Gram-negative bacteria was observed, contrary to expectations. The variations in efficacy based on bacterial type warrant further investigations to better understand and harness these antimicrobial effects.

Keywords: Bacteria, growth, natural, oils, antibiotics

[11] Comparing the Rates of Induced Resistance to Ciprofloxacin and T4r Bacteriophages in *Escherichia coli B*
Nabiah Sheikh | Niles West High School

Purpose: The purpose of this investigation is to compare the effectiveness of phage therapy to antibiotic therapy in its effectiveness against antimicrobial resistance.
Procedure: The experimenter started the Plaque-Forming Assay by adding 0.3 mL of *E. coli B* bacterial solution to 8 tubes of soft agar. In 4 tubes, 0.1 mL of T4r bacteriophage was added. The soft agar from each tube was poured onto a sterile LB Agar plate and rested for 48 hours. After 48 hours, the number of plaque forming units for each plate were measured and recorded. The plate with the least amount of plaque-forming units is selected for both groups. Then, the experimenter uses an inoculating loop to pick up the plaque(s) and put into a sterile broth. This broth is added to 4 new tubes (per group) of sterile soft agar. The soft agar from each tube is poured onto 8 sterile LB Agar plates. The Experimenter started the Kirby-Bauer Assay by streaking 8 LB Agar plates using an inoculating loop with an *E. coli B* bacterial solution. Next, a ciprofloxacin disk was placed on 4 of these plates, and sterile disks were placed on the other 4. These plates were incubated at 37 degrees Celsius for 48 hours upside down. After 48 hours, the size of the zones of inhibition of each plate is measured and recorded. The most resistant plate out of the 4 (of each group) is selected. Then the experimenter uses an inoculating loop to pick up the bacteria from the most resistant plate and swab it onto 4 new plates. Then, the respective disk is placed onto the newly swabbed plates. This is repeated until both the antibiotic and bacteriophage are deemed ineffective.
Conclusion: The hypothesis was supported because the antibiotic was deemed ineffective many generations prior to the bacteriophage. From the data collected, it is noticeable that the T4r bateriophage continues to work effectively multiple generations after the ciprofloxacin no longer works to its full capacity. This shows that phage therapy could potentially act as an effective form of treatment while decreasing the risk of antimicrobial resistance.

Keywords: Bacteriophage, Resistance, Evolution

[13] Developing a high-accuracy targeted *de novo* sequence assembly pipeline

Sophie Surheyao | University Laboratory High School at University of Illinois Urbana-Champaign

Sequencing technologies, which allow for the analysis and interpretation of genetic material, have become an indispensable tool for biological research. As sequencing has evolved to produce increasing amounts of data, sequence assembly tools with a wide variety of modalities have become increasingly necessary. Many current assembly tools can assemble a genome or transcriptome with relative accuracy. However, these tools have decreased accuracy at the level of individual genes or transcripts, especially for non-model organisms. Thus, there is a need to develop *de novo* assembly tools with higher degrees of specificity. This study develops a targeted, high-quality *de novo* sequence assembly pipeline utilizing Python and Bash Shell scripting. The pipeline was tested on RNA-Seq datasets of 1, 2, and 5 million reads. The pipeline greatly reduces time spent per assembly compared to current manual *de novo* approaches, though requires further optimization for efficiency across a wide range of read depths. Currently, this novel pipeline is being utilized to study photosynthetic evolution for non-model grasses. This pipeline facilitates various analyses such as transcript evolution, mutations, and structural differences between species.

Keywords: high-throughput sequencing, Python, photosynthesis, transcript assembly

[15] Effects of Ampicillin and Amoxicillin Exposure on the Nervous System Regeneration of *Schmidtea mediterranea*: A Novel Toxicology Assessment With Applications for Global Neonatal Health

Marina Sjoblom | Oak Park and River Forest High School

Ampicillin and amoxicillin are two highly impactful penicillin antibiotics utilized to treat neonatal sepsis and other widespread diseases, improving the health of millions of young individuals across the globe. Recently, human and animal based studies have identified an association between early life exposure to first generation penicillins and dysregulation of several neurological pathways. However, this association has not yet been established for ampicillin and amoxicillin, thoroughly tested third generation penicillins related to but chemically different than their first generation counterparts. This experiment utilized a novel animal assessment, the regenerative asexual planarian *Schmidtea mediterranea* (*S. med*), to better understand the neurological effects of early life ampicillin and amoxicillin exposure. *S. med ChAT* (choline acetyltransferase) and *sert* (serotonin transporter) genetic expression after exposure to ampicillin or amoxicillin during brain regeneration was noted with colorimetric analysis and compared to the genetic expression of a negative control not exposed to any antibiotic. *sert* clusters were numerically quantified. Ultimately, worms exposed to ampicillin and amoxicillin exhibited no statistical difference in visible *sert* expression from those without any exposure to antibiotics (Kruskal-Wallis ANOVA, p=0.9623). These findings reflect the results of similar studies and support the safety of ampicillin and amoxicillin. This experiment also investigates the use of *S. med* to determine the toxicity of certain substances. After further research, these worms have the potential to be utilized as comprehensive developmental toxicology models in commercial and academic settings.

Keywords: critical developmental periods, ampicillin, amoxicillin, Schmidtea mediterranea, novel toxicology assessment

[17] Effects of *Phaleria macrocarpa* Fruit Extracts on the Viability and Proliferation of J2 Transformed BV-2 Microglial Cells to Determine a Novel Plant-Based Treatment of Brain Cancer

Angela Ho | Adlai E. Stevenson High School

Brain cancers, in particular gliomas, are the most aggressive brain diseases in humans and have very low survival rates, causing over 18,000 deaths per year in the United States. *Phaleria macrocarpa*, or "God's Crown", is an herbal plant containing numerous secondary metabolites including flavonoids and alkaloids, and exhibits antiproliferative and anticancer properties. The purpose of this study was to investigate the effects of various dosages of *Phaleria macrocarpa* fruit extracts on the viability and proliferation of J2-transformed BV-2 microglia in order to determine a novel plant-based treatment of brain cancers with lower treatment cost and risk of negative health effects for patients. 4 groups were involved in this experiment: a negative control group that received no treatment of *Phaleria macrocarpa* fruit extracts, a treated control group (100 µL distilled H2O), low dose group (50 µL fruit extract & 50 µL distilled H2O), and high dose group (100 µL fruit extract). Trypan-blue cell counting was conducted after the 24h treatment period to measure cell proliferation in each group. The percentage of living cells in each counted sample was then calculated to measure cell viability in each group. All data was compared to the two control groups to determine the impact of the presence and dosage of *Phaleria macrocarpa* fruit extract on the growth of immortalized BV-2 microglia. *Phaleria macrocarpa* fruit extract exhibited no significant effect on the viability or proliferation of J2-transformed BV-2 cells. This experiment was the first to examine the effects of *Phaleria macrocarpa* extracts on brain cancer cells.

Keywords: Brain cancer, God's Crown, microglia, cell proliferation, flavonoids

[19] Evaluate the Antimicrobial Effect of *S. Epidermidis* Against Maitake Mushroom Extract

Hana Shamsudeen | Adlai E. Stevenson High School

Purpose: The purpose of this experiment is to determine the antimicrobial effect of Maitake mushroom *(Grifola frondosa*) extract against *Staphylococcus epidermidis (S. epidermidis)*. The goal is to evaluate the dose-dependent inhibitory effects of Maitake extract on *S. epidermidis* growth to understand its potential as a natural alternative to antibiotics for treating infections caused by this bacterium.
Procedure: The antimicrobial efficacy of Maitake mushroom extract against *S. epidermidis* was tested via the disc diffusion assay. Maitake powder was dissolved in sterile water to prepare a 12mg/mL solution (1g powder in 2.5 mL water) and a 90mg/mL solution (5g powder in 5 mL water), representing two different concentrations. Nutrient agar plates were prepared and streaked with a lawn of *S. epidermidis* culture using the spread plate technique. Paper discs were then saturated with 0.1 mL (100 µL) of either the 12mg/mL or 90mg/mL Maitake extract solutions, Tetracycline antibiotic discs as the positive control, and blank discs as the negative control. Plates were incubated at 30-35°C for 72 hours and the zones of inhibition were measured in millimeters. The experiment was performed in ten individual samples for each concentration and the results were analyzed statistically. This methodology allowed a comparison of the dose-dependent inhibitory activity of Maitake mushroom extract against *S. epidermidis*.
Conclusion: The hypothesis stated that if agar plates streaked with S. epidermidis are incubated for 72 hours at 37°C with discs saturated with two different concentrations (12 mg/mL and 90 mg/mL) of Maitake extract, as well as a Tetracycline antibiotic disc as a positive control, the maitake extract disc with 90mg/mL will produce larger zones of inhibition than the 12mg/mL and that the tetracycline discs would be higher than the 12mg/mL discs but lower than the 90mg/mL discs. The results supported the hypothesis. The mean zone of inhibition for the 90mg/mL was 29.70mm, while the 12mg/mL was 12.70mm ($p < 0.0001$). However, the zone of inhibition for the tetracycline was significantly higher than the 12mg/mL ($p < 0.0001$), but lower than the 90mg/mL ($p < 0.0001$). In conclusion, this study exhibited that Maitake extract has dose-dependent antimicrobial activity against *S. epidermidis.*

Keywords: Natural, effective, resistance, fungi, microbiology

[21] Examining the Effects of Light on Sleep and Circadian Rhythm in Young Adults
Andrew Wong | Illinois Mathematics and Science Academy

This research investigates the impact of light on sleep and circadian rhythm in adolescents and young adults. Light serves as a primary regulator of circadian rhythms, influencing sleep-wake cycles and overall health. By synthesizing findings from various studies, we explore the effects of light intensity, duration, and wavelength on sleep patterns and circadian timing. Studies demonstrate a gradual shift towards later bedtimes during adolescence, potentially linked to changes in circadian timing. Furthermore, research highlights the differential sensitivity to light between pre- to mid-pubertal and late to post-pubertal adolescents, with shorter wavelengths of light exerting a more significant impact on circadian rhythm and sleep architecture. Understanding these dynamics is crucial for designing interventions to promote healthy sleep habits and overall well-being in adolescents and young adults. To investigate this discussion, a meta-analysis of several studies was compiled to predict and determine the effects of differing wavelengths of light on circadian rhythm and sleep. It is anticipated that adolescents and young adults exposed to higher intensities of light, particularly during the evening hours, will exhibit delayed onset of melatonin secretion and consequently experience later bedtimes. Additionally, it is planned to see that data that is gathered during the violet wavelength light stage has the most substantial influence on the phase response curve, drastically shifting the onset of melatonin, which will thereby affect the subject's circadian rhythm. This investigation contributes valuable insights into the role of light in shaping sleep patterns and circadian rhythms during critical developmental stages.

Keywords: sleep, circadian rhythm, light

[23] Exploring the Impact of Ceramide Synthesis Enzymes on Atopic Dermatitis Severity
Mikaella Moraga | Illinois Mathematics and Science Academy

Atopic dermatitis (AD; eczema) is a chronic skin disorder characterized by inflammation, itching, and compromised skin barrier function. Pathogenesis involves genetic factors, immune dysregulation, and skin barrier ceramide alterations. This research project explores the relationship between the ceramide *de novo* pathway and AD severity. Severity was determined serially based on assessing erythema, scaling, edema, and erosion using a 12-point scale (each 0-3) in a mouse model of AD induced by MC903 application on the ear. Ear samples were collected on challenge days 1, 4, and 9. RNA was extracted for quantitative real-time PCR to assess changes in biomarkers. Maximum severity was reached at 4 days in terms of the clinical severity scale and cytokine changes. As found in human AD, expression of *Sptlc3*, encoding a key enzyme in *de novo* ceramide synthesis in differentiated skin, was significantly reduced in control mouse skin treated to induce AD. However, mice with the knockout of *Sptlc3* did not develop AD spontaneously and, when treated topically with MC903, did not show increased AD severity or skewing of cytokines. These results suggest that other factors involved in *de novo* ceramide synthesis can compensate for the reduction in *Sptlc3* in mouse skin, which deserves further exploration.

Keywords: Atopic dermatitis, skin barrier, enzymes

[25] Facial Recognition Doorbell
Ansh Gupta and Jack Legner | University High School at Illinois State University

Abstract not provided.

Keywords: Recognition, Raspberry Pi

[27] Fine Tuning LLMs for Financial Advice and Economic Analysis
Smriti Kumar and Meghana Mandava | Adlai E. Stevenson High School

Despite recent advancements in Generative AI and Large Language Models (LLMs), their use as powerful tools of economic indication is largely unexplored. As the economy has been largely unpredictable in recent years, constituents within the US need to be more informed about the state of the economy and financial decisions, so it is imperative to explore the potential of LLMs within this field. This project aims to apply LLMs to a variety of situations to not only predict the sentiment of financial news headlines to provide an outlook on the short-term market, but to also create a chatbot tool that offers financial advice to users. The LLM will be tested by prompt engineering to determine the most optimal and accurate model. Open AI's GPT-3.5 model will be finetuned through changing its prompt, or input of varying semantic complexity and specificity to analyze the sentiment of news headlines. A personal finance chatbot will then be created utilizing the GPT model through Gradio. After engineering varying degrees of prompts, the initial hypothesis was supported and the most specific prompt beginning with the verb "Classify" was found to produce the highest accuracy when analyzing the sentiments of news headlines, due to the combination of both task directive and investigative language, and a specific role defined for the LLM. For the financial chatbot, the moderate prompt, which was neither too specific nor too general, was found to fit the optimal role of a financial advisor chatbot, outputting the quickest and most concise response.

Keywords: Large language models, finance, economics, fine-tuning, chatbot

[29] Flames of Renewal
Mariano Ramirez | Oswego East High School

Abstract not provided.

Keywords: Ecological succession, Nutrient Cycling, Fire

[31] FlaviExplore: An Integrated Bioinformatics Platform for West Nile Virus (WNV) Research
Aarav Patel | IMSA/RISE

This experiment developed the FlaviExplore platform with a main goal of making gathering West Nile virus (WNV) data simpler for researchers and extending phylogenetic knowledge about WNV. Currently, many researchers have to spend an excessive amount of time gathering sequences and converting them to fasta files, which could slow down the process of gaining new insights about the virus. This platform, comprising an integrated database and website, centralizes WNV genetic information and enables simple extraction and analysis of WNV sequences. The phylogenetic analysis done also extends knowledge related to WNV genetic diversity across multiple regions. The project involved collecting WNV DNA sequences from both the ViPR and the BVBRC databases and converting them into csv files for storage in a Cosmos database. The fasta sequences were utilized in developing the FlaviExplore website, a platform that made WNV sequences easily accessible for analysis. The sequences were then analyzed using a multitude of bioinformatics software, leading to the construction of a phylogenetic tree and the study of genetic variants among WNV strains. The universally negative Tajima's D values point to significant expansion or new evolutionary pressures in WNV populations, highlighted by considerable genetic diversity, which contradicts the null hypothesis of the experiment. This genetic diversity provides valuable insights into its population structures. Such knowledge is crucial for understanding the essential for controlling WNV spread and developing effective antiviral treatments. FlaviExplore provides an efficient method for gathering WNV fasta files for WNV researchers, further increasing WNV knowledge.

Keywords: West Nile Virus, Flavivirus, Genome Sequence, Bioinformatics, Phylogenetic Analysis

[33] How Different Music Styles Impact Systolic Blood Pressure in Adolescents
Diptasha Chakrabarty and Kyra Sahni | Adlai E. Stevenson High School

The purpose for this project is to determine the effect of different genres of music within adolescents' systolic blood pressure. This is important because it informs the reader about an efficient way to prevent high blood pressure in the future. Three experimental control groups were set up. Each experimental group had to listen to 2 minutes of a specific music genre after 30 seconds of doing jumping jacks to elevate their blood pressure: classical, jazz, and heavy metal to see which one lowered their elevated systolic blood pressure the most. The control group listened to no music. The rate of change of systolic blood pressure was measured right after listening for 2 minutes. The experimental group’s rate of change that had jazz music was much greater than compared to other music genres. In fact, for heavy metal music, the rate of change was insignificant or almost 0. This did the complete opposite of what music (in general) was supposed to do. The control group was just behind the jazz group in terms of reducing BP. The analysis on classical music is inconclusive since the data spread is large and thus a conclusive inference is difficult at this time. The hypothesis was not supported because the group that listened to jazz music after exercising had the greatest rate of change in systolic blood pressure, not the classical group as hypothesized. A possible explanation for this is the demographic that was tested, as many adolescents prefer the tone/style of jazz music.

Keywords: Music genre, systolic blood pressure, rate of change, adolescents

[35] Impact of Vitamin C on behavior of *C. Elegans* exposed to nicotine

Kyle Guliana | Niles West High School

Purpose: Nicotine has long been a cause of numerous behavioral irregularities in the human body, such as anxiety, depression, and changes in movement, reproduction, and diet. The presence of free radicals that is associated with nicotine intake is a significant factor as to why these irregularities are present. Previous research on free radicals has shown that antioxidants can target them directly, and by doing so, they are refrained from growing and multiplying. This study aims to understand how Vitamin C can reduce the behavioral irregularities found in nicotine-induced *C. elegans*.

Procedure: *C. elegans* were separated into 4 different dishes; 2 being the control and 2 being experimental. For the first two weeks, the two groups studied were the control and the nicotine-induced by using both qualitative and quantitative observations. After the 2 weeks are concluded, the previous experimental group will be replaced with nicotine and the addition of ascorbic acid (vitamin C).

Conclusion: In conclusion, the hypothesis was mostly proven correct, as the pharyngeal pumps per minute and the amount of eggs present in each group showed that those exposed to nicotine and vitamin C had higher numbers for both of these variables. However, the movement did not prove the hypothesis, and this was concluded due to visualizing the error bars, and seeing overlap.

Keywords: Vitamin C, nicotine, behavior, C. Elegans

[37] Logistic Regression to Achieve Efficiency in Grouping Cancer Mutations Into One of Nine MSKCC Classes

Ananya Nair, Suchita Rao, and Sahasra Chatakondu | Metea Valley High School

Due to the thousands of genes in our body along with their unknown variants, it is very time-consuming for geneticists to determine the type of mutation a cancer patient has and come up with a treatment plan manually. Personalized treatments for cancer patients will change the outlook of treatment plans for these individuals, as it takes into consideration the specific genetic makeup of a tumor and mutation. This process, traditionally, is very tedious since it forces pathologists and geneticists to individually classify cancer-related genetic material by reviewing several medical papers and past studies. However, machine learning can cut screening workload time when classifying mutation labels. In this study, we employ a logistic regression classifier to group gene mutations into the nine different class labels developed by MSKCC (Memorial Sloan Kettering Cancer Center); after reviewing various medical abstracts to understand a single gene and its specific variation, pathologists can implement personalized treatment plans. Our model achieved a 1.035 log loss value and when considering the primary stages of this technology, it is impressive for a machine to decipher such a complex task and only creates a gateway of opportunities for the future. These outcomes are promising for cancer patients and can revolutionize the future of cancer treatment. As the research about individual attributes of genes accelerates, the accuracy of machine learning will enhance when predicting more precise personalized treatment options.

Keywords: Personalized medicine, logistic regression, gene mutations, efficiency

[39] Neuroprotective Effects of a Combination of Celastrol and Naproxen on Acute Traumatic Brain Injury in a *Drosophila melanogaster* Model as a Potential Novel Pharmaceutical

Amelia Hammersley | Oak Park and River Forest High School

Traumatic brain injury (TBI) is the leading cause of death among all traumatic injuries. While there are some treatments, such as nonsteroidal anti-inflammatory drugs (NSAIDs), most cause debilitating side effects including cerebral ischemia and neurodegenerative diseases. Alternatively, some clinical trials have demonstrated that natural compounds, including celastrol, can be effective in administering neuroprotective effects following TBI. This experiment developed a novel pharmaceutical treatment for TBI containing a natural compound, celastrol, and the NSAID, naproxen. For this experiment, *Drosophila melanogaster* were administered TBIs, and given either 1. naproxen, 2. celastrol, or a combination of both in order to ascertain if a combination of celastrol and naproxen was equally neuroprotective to naproxen alone. The experiment results indicate that the combination treatment significantly increased neurological function to the same extent as solely naproxen. With further research, this novel pharmaceutical could be used as an alternative to naproxen alone to eliminate neurological deficits caused by TBIs as each medication works via a different mechanism. All experimental groups demonstrated a significant level of neuroprotection (one-way ANOVA p-value < 0.0001), with respect to a climbing assay. Further research should be conducted to verify these findings, in both *in vivo* and *in vitro* models.

Keywords: Traumatic brain injury, neuroprotectivity, non-steroidal anti-inflammatory drug (NSAID), celastrol, Drosophila melanogaster

[41] Novel AI-Based Adaptive SCN Treatment Medical Device for Circadian Misalignment

Benjamin Brown, Pranav Dharmappa, and Michael Xi | University High School at Illinois State University

Despite circadian misalignment’s contribution to $418 billion in lost productivity each year, existing medical devices for treatment are ineffective. This is because dozens of neurobiological factors, which determine the circadian chronotype, cause users' responses to treatment to be vastly different. The one-size-fits-all treatment used by medical devices in previous studies does not account for this. This study aims to design a novel medical device to address circadian misalignment that uses autonomous adaptive treatment to adjust for individual users and the external environment for increased effectiveness. This novel device first uses unconventional and unique designs of sensors that offer optimized cost and advanced ultrasmall electronics to measure biometrics of individual users that are indicative of treatment effectiveness such as cerebral blood flow and pulmonary rhythms, which are recorded into an AWS Timestream database. Cloud-based heteroscedastic machine learning then uses this data to improve effectiveness by adjusting various aspects of the treatment, such as periodicity, intensity, and duration, with supervised decision trees. Several devices were constructed and tested on participants for one week while performance measures of cognitive performance were recorded. The designed medical electronics cost less than $15 while achieving similar accuracy to industry-standard equipment that costs $5000, showing significant promise in the economic feasibility of the device that is crucial to the widespread treatment of circadian misalignment. Overall, the adaptive treatment in the experiment vastly improved cognitive function upon waking as PVT, KSS, and N-back optic test scores consistently increased by over 20%, representing a significant improvement from previous studies.

Keywords: Circadian Misalignment, AI, Adaptive, Treatment

[43] Novel Convolutional Neural Networks for Improved Accuracy in User-Accessible Brain Tumor Detection and Classification

Kevin Tian | IMSA/RISE

Effective treatment for brain cancer is aided significantly by the rapid detection of tumors. Traditional detection methods involving the manual inspection of Magnetic Resonance Imaging (MRI) scans have been established to be slow, consuming large amounts of time both for the specialist and the patient. The purpose of this design investigation was to propose and develop three artificial intelligence (AI) models, specifically, convolutional neural networks (CNNs), employing novel techniques to quickly and accurately detect the presence and type of brain tumors from MRI scans. The goal was to provide medical professionals with a faster alternative compared to traditional, manual detection methods by overcoming inefficiencies and reducing human error. The design was also able to address various gaps and limitations in existing studies, most notably, the lack of a user interface (UI) for easy and practical accessibility. Therefore, in this design, the highest performing CNN, utilizing the pretrained VGG19 architecture—with a validation accuracy of 98.06% and validation loss of 0.02—was integrated into a minimalistic, open-source UI website using the Gradio library, enabling hospital workers to upload MRI images with ease for tumor identification, facilitating real-world applications and usage in various understaffed medical settings.

Keywords: cancer, brain tumor, Magnetic Resonance Imaging (MRI), Artificial Intelligence (AI), Convolutional Neural Networks (CNNs)

[45] Novel Intelligent Optical Computing Method for Fast and Energy Efficient Big Data Processing

Aarushi Tiwari | Adlai E. Stevenson High School

The rising demand for Big Data processing is expected to become unmanageably costly and energy inefficient in numerous fields of science. Industries currently employ resource-intensive electronic-based algorithms to filter data. This project proposes a novel two-level filtration system using the Hybrid Opto-electronic Correlator (HOC) powered by Spiking Neural Networks for discrete data processing. Through harnessing light-based technology, it aims to boost computing speed by up to 1000 times and reduce power usage by up to 100 times compared to current electronic systems. CERN and LIGO are explored as use cases. The optical convolution and correlation was incorporated in all neural network designs using a custom simulation of the HOC. Three iterations were tested: Optical Composite Image Method, Optical Convolutional Neural Network, and Optical Convolutional Spiking Neural Networks (OCSNN). The code for all neural network iterations and simulations of the HOC was written using Tensorflow, PyTorch, Spyketorch, and MATLAB. Implementation of Spiking Neural Networks required images to first be converted into a discrete time-based format using an intensity to latency transform. The networks were trained on LIGO spectrogram images and CERN abstract images of photons. The OCSNN was chosen as the final iteration due to its high energy efficiency and high performance with accuracy of 84% and 85% for CERN and LIGO respectively. This project successfully demonstrated the potential of the HOC and OCSNNs as a low cost, high speed, and energy efficient method for Big Data processing across numerous science industries, marking a paradigm shift away from current electronic-based methods.

Keywords: Big Data, Optical Computing, Machine Learning, Spiking Neural Networks

[47] Novel Thermopile System to Increase the Fuel Efficiency of Internal Combustion Engines to Help Mitigate Climate Crisis

Anne Claud | Oak Park and River Forest High School

Heat recovery systems provide an environmentally friendly way to reduce carbon emissions produced by internal combustion engines. While heat systems vary in form and integration into a cars system, heat recovery systems generally provide additional voltage produced by a temperature gradient, the flow of a liquid or air, or other energy-producing means. The voltage produced by these systems is then reintegrated back into the vehicle. This reintegration of additional electricity reduces the load on the alternator, the part of the car that produces the electricity needed to run a car and charge the battery. When the load on the alternator is reduced, the load on the engine is reduced, limiting the amount of fuel used. This experiment was conducted to determine if using a novel heat recovery system, a thermopile, in addition to a step-up transformer, would produce enough electricity to reduce the load off of the engine, effectively increasing fuel efficiency. The results did not support the experimental hypothesis, as the voltage needed was not produced by the electrical configurations constructed. However, a Bonferroni correction test determined that the correlation between the independent variable temperature and dependent variable voltage is statistically significant, with a *p*-value of <0.0001. In addition, the results support the continuation of the research in the search for a more advanced modification that would support the experimental hypothesis.

Keywords: Fuel efficiency, heat recovery system, internal combustion engine

[49] Optical Aperture Synthesis in Sub-Kilometer Baselines via Interferometry

Muhammad Ammar | Niles West High School

Abstract not provided.

Keywords: Image, Aperture Synthesis, Interferometry, Image Analysis, Computer Science, Telescope

[51] Optimization of Aerodynamic Efficiencies in Next-Generation Electric Vehicles

Marc Cheng | Woodstock High School

Enhancing aerodynamic efficiencies in next-generation electric vehicles (EVs) is crucial for improved performance and energy efficiency. This study combined physical airflow tunnel experiments with airflow model simulations to analyze various car shapes and brands. Initially, wind tunnel experiments provided a baseline for aerodynamic optimization. Subsequently, 3D simulations explored the effects of design parameters like wheel diameter, trunk height, and aspect ratio on aerodynamic performance. Results showed that increasing wheel diameter reduced drag by minimizing airflow disruptions, while optimizing trunk height and aspect ratio improved airflow patterns and reduced drag coefficients. Future research could adopt a holistic approach, incorporating multi-objective optimization techniques to balance aerodynamics, vehicle weight, and other performance metrics, thus enabling the development of EVs with enhanced efficiency and performance.

Keywords: Aerodynamics, Energy Efficiency, Electric Vehicles

[53] Permafrost Thaw in Relation to the Photosynthetic Pathways and Abundance of *Chlorophytum comosum, Sedum angelina*, and *Senecio cineraria* to Limit Thermokarst Action

Ashrith Valluri | IMSA/RISE

The purpose of this research was twofold: 1) to investigate if plants that used varied photosynthetic pathways (C_3 or CAM) decrease permafrost thaw amount and subsequent CO_2 accumulation and 2) ascertain if plant abundance has any additive impact. This experiment addressed a significant gap regarding the analysis of photosynthetic pathways in relation to CO_2 change and permafrost thaw. The ultimate application of these findings is to combat climate change trends, devise solutions for small communities in permafrost regions through plant photosynthesis, and aid in the analysis of plant processes. Plants were selected from CAM and C_3 groups due to their variations in methods of CO_2 fixation through the enzyme rubisco. Three groups were established with a control group that did not include plants, experimental group 1 (E1) with one plant per trial, and experimental group 2 (E2) with three plants per trial. For all groups, 20 trials were taken per species (n=20). Simulated permafrost ground was created and the CO_2 sensor was calibrated to mimic permafrost thaw and CO_2 concentration respectively. Data determined that *C. comosum* (C_3 plant) was most efficient in reducing CO_2 and permafrost thaw due to being most suitable to the experimental environment. From Tukey post-hoc results, part of the null hypothesis was rejected regarding CO_2 change due to strong variations between the groups ($p < 0.05$), however, could not be rejected regarding permafrost thaw. The null hypothesis was rejected and the experimental hypothesis was supported.

Keywords: Permafrost thaw, thermokarst, CO2 fixation, global warming, and photosynthesis

[55] Sentiment and Topic Modeling in Tweets and News Articles from the Russia-Ukraine War

Himani Musku | Illinois Mathematics and Science Academy

Beginning in February 2022, Russia's invasion in Ukraine marked one of the largest invasions of a European country since World War II and impacted numerous people worldwide. Our project aims to study public opinions and topics of discussion during this international crisis by analyzing daily tweets and news articles from April 2022 to June 2023. For our analyses, we utilized various Natural Language Processing libraries in Python to identify shifts in topics and compute sentiment. We used the BERTopic model to create topics and categorize tweets and news articles by topic. After applying a sentiment model on the tweets, we discovered the sentiment distribution of the tweets was 57% positive, 34% negative, and 9% neutral. Additionally, we investigated the correlation between the location associated with a tweet and its sentiment and found that tweets located in Nigeria and India were predominantly positive, while those in Ukraine were mostly negative. Furthermore, using a hashtag-prediction model, we determined that the majority of tweets and news articles were pro-Ukraine or neutral, while almost none were pro-Russia. These findings share valuable insights into the global perspectives on the Russia-Ukraine war as well as provide a framework for future analyses on other international crises.

Keywords: Sentiments, Topics, War, Opinions, Models

[57] Steger Water Quality: An Analytical Exploration
Gabriella Cantu | Oswego East High School

This investigation was a study on the consistencies of the water quality reports of Steger Illinois and the possibilities of groundwater contamination of heavy metals from local operating and retired factory facilities. This analysis was carried out through a collection of potable and non potable water samples from residents in the region of Steger, both from those who use city water as well as those who use groundwater in order to compare the quality of both. In addition to this, samples were collected from local waterways in the region. Through interviews with residents as well as an in-depth review of water data reports from neighboring regions, the evidence collected in the duration of this exploratory study supports the overarching aim to exemplify the benefits residents could receive from regulatory on-site water quality testing and monitoring of facilities operating in the region.

Keywords: Water quality, pollution, groundwater

[59] The Biophysical Characterization of Salt-Leached Poly-lactic Acid (PLA) Bioscaffolds Fabricated by Thermomolding: A Novel Method With Applications for Tissue Engineering
Jessica Li | Oak Park and River Forest High School

Tissue engineering (TE) serves as a promising alternative to relieve the intense demand of conventional tissue grafts, and divert some of the associated risks, such as immunosuppression and rejection. Bioscaffolds are porous and hydrophilic 3D matrices used to support tissue growth in vitro, making them a crucial component of TE. However, despite numerous fabrication protocols reporting viable scaffolds for clinical use, these methods often do not consider time-efficiency, cost-effectiveness, and safety, which hinders their real world applications. This experiment introduced a modified salt particulate leaching method utilizing solvent-free poly-lactic acid (PLA) thermomolding. PLA pellets were melted in a silicone mold using a commercial toaster oven. Sodium chloride crystals were then laid on and allowed to sink into the molten polymer to create the porous structure, before they were leached through dissolution in water. The completed scaffolds were then physically characterized based on their porosity, water contact angle, buoyancy, and degradation rate. While certain qualities were not completely optimized, this procedure provided preliminary evidence and proof of concept. The experimental scaffolds exhibited a porosity of 30.24 ± 2.380% (± 95% CI), the highest of the three groups (ANOVA p-value<0.0001), which was further supported by their frequently buoyant behavior. The porous surface was also significantly hydrophilic (<90°), with an average top side water contact angle of 52.59 ± 4.209° (± 95% CI). The scaffold weight also remained stable throughout a seven-day degradation test in *in vivo* conditions. Further research is necessary to draw more definitive conclusions on the viability of these scaffolds

Keywords: bioscaffold fabrication, polylactic acid (PLA), thermomolding, salt-leaching, tissue engineering

[61] The Effect of Electrolyte Concentration, Temperature, and Electrode Material on the Electrical Current Produced During Water Electrolysis for Green Hydrogen Production

Pranav Venutur | Adlai E. Stevenson High School

Climate change is a major issue that humans need to immediately address for the sake of the planet. Currently, hydrogen is a key ingredient used in many industries, but over 95% of hydrogen is produced from natural gas, which results in greenhouse gas emissions. Water electrolysis using renewable energy produces hydrogen without any greenhouse gas emissions, however it is quite inefficient and costly. If the world can transition to using electrolysis for hydrogen production, it will be in a healthier state overall. To make this transition, the process must be tuned for maximum efficiency. Efficiency depends on many factors, including electrolyte strength, temperature, and electrode type, so this experiment was designed to vary the concentration and temperature of a sodium bicarbonate solution, as well as the material of the electrodes and determine the conditions at which highest electrical current and therefore most hydrogen is produced. A basic electrolysis set up and DC power supply was used. It was found that the hydrogen production rate increased with the electrolyte concentration, however the additional per gram current decreased as the concentration increased. Furthermore, higher temperature resulted in higher current. Lastly, zinc electrodes were found to be far more efficient but less stable than nickel electrodes as the anode deteriorated quickly due to the surrounding oxidizing environment

Keywords: Electrolysis, green hydrogen, optimal conditions

[63] The Effect of Various Fin Designs on the Stability, Apogee, and Drag of Model Rockets to Maximize Efficiency

Varun Nagaraj | IMSA/RISE

The design of the fin is one of the essential elements required for the successful launch of a rocket. The shape of the fin can affect the rocket's stability, apogee, and drag coefficient, among many other factors. This experiment aimed to ascertain if different fins for model rockets impact their stability, apogee and drag in order to provide an optimal design for new rockets. This experiment addresses a current gap, a lack of research into the physical components of rockets. Using the OpenRocket software, three different model rockets were designed. These were then built physically and were launched multiple times, both physically and in simulations, to collect data. Then, the data were analyzed to find the differences between the performances of each of the fins, and determine which fins maximized the efficiency of the rocket. Overall, the data showed fairly consistent results with clear differences in the experimental and control groups. In the data from simulated launches, the Analysis of Variance (ANOVA) test showed statistically significant results with *p* values below 0.0001, meaning that the null hypothesis is rejected and that the experimental hypothesis is supported. The null hypothesis is rejected due to the higher reliability of the data from the simulated data set. This shows that there is significant difference in the performance of the three fin models and that the control group’s fins can be used to optimize the performance of rockets today.

Keywords: Drag Coefficient, Apogee, Model Rocket, Fins, Stability

[65] The Effects of Different Prosthetic Foot and Ankle Stiffness Combinations on Transfemoral Prosthesis Users
Rachel Coutinho | Illinois Mathematics and Science Academy

The study investigates how different prosthetic foot stiffness levels affect foot-ankle roll-over shape and its implications for stability during gait. The aim is to enhance gait function and prosthetic design for transfemoral prosthesis users. The study mechanically characterized the keel and bumper components on the College Park Venture Foot, which revealed an increasing stiffness from soft to hard configuration. The stiffness of the soft keel soft bumper combination was 43.354 N/mm and the stiffness of the hard keel hard bumper combination was 61.429 N/mm. Kinematic and kinetic data were utilized to create the roll-over shape radii of the different combinations. A novel MatLab method was developed to create a best-fit circle of the roll-over shape and can be applied in future studies when a portion of the data is linear as the constraints mitigate the linear portion's impact on the ROS radius calculation. Minimizing the standard deviation allows for a streamlined procedure to create a best-fit circle while maintaining the outcome precision. The method revealed a radius of 265.5 mm for soft keel soft bumper and a radius of 342.1mm for hard keel hard bumper. All the different keel-bumper combinations in the roll-over shape experiment were proportional to their measured stiffness in the mechanical testing. As the optimal ROS parameters for ambulation and standing create a range of ROS radii, the clinician can alter the foot-ankle stiffness combination in the prescription to optimize the user's gait.

Keywords: prosthetics, stiffness, roll-over shape, MatLab, ankle unit

[67] The Impact of Different Turmeric Concentrations on *Escherichia coli* Growth
Sadhana Anbazhagan | Adlai E. Stevenson High School

Independent Variable: Concentrations of turmeric and ethanol were added to the filter paper disk: 0% (just ethanol), 20%, 40%, 60% and 80%.
Dependent Variable: Zone of Inhibition of the bacteria.
Procedure: Mix 14g of turmeric powder with 40 mL of ethanol 1. Add different amounts of ethanol for each concentration (0%, 20%, 40%, 60% and 80%) 2. Spread *E. coli* evenly on the Agar Plates 3. Split 10 agar plates into 4 sections and label the positive and negative control, 0%, and 20%. 4. Spilt 10 agar plates into 3 sections and label them 40%, 60%, and 80%. 5. Use forceps to place 1 filter paper disc for each section in all the plates. 6. Add the appropriate turmeric solution to each filter disc. 7. Incubate the plates for about 24-48 hours and measure the zones of inhibition.
Data: The data was presented using a table. The sterile disk placed as the negative control to show the growth of bacteria showed no growth in four plates which were not measured. The positive control which had the antibiotic tetracycline was the only control that had a zone of inhibition. None of the other variables and controls had any zone of inhibition. This shows that the different concentrations of turmeric did not inhibit *E. coli* from growing.
Conclusion: The study aimed to determine the effect of different turmeric concentrations on *E. coli* growth. However, the results did not support this hypothesis, as the disks with higher turmeric concentrations had a larger zone of inhibition. The only zone of inhibitions were seen in the positive control using Tetracycline disks. The experiment needs to be repeated due to the unusual results. The disk with ethanol had no reaction, which made the experiment unusual and no firm conclusion can be drawn.

Keywords: Turmeric, Concentration, Bacterial Growth, Inhibition

[69] The Impact of Niacin on Planarian Regeneration

Jadesola Alao | Niles West High School

This study explores the effects of varying niacin concentrations (0.12 mg/L, 0.36 mg/L, and 0.6 mg/L) on breast cancer using *Planaria* as a model organism. It investigates niacin's influence on *Planaria*'s regenerative response and its potential in breast cancer treatment. Five planarians are housed in each 100 x 15 petri dish, acclimating for 24 hours and fed 0.03g of eggs weekly. Niacin solutions are prepared, and two control groups are established. Planarians' body lengths are measured using a cm ruler after niacin solutions are added. After two days, planarians are halved, and regeneration time is noted. Planarian behavior is observed, and regrowth is measured. Regeneration quality is assessed by comparing planarians with initial images. Experimental results partially support the hypothesis, with higher niacin concentrations inhibiting growth in some instances, notably Trial 1, though Trial 3 showed inconsistencies. Despite this, some trials hint at niacin's potential in inhibiting breast cancer cell growth. Further research is needed to fully understand niacin's impact on breast cancer cell growth, as well as continuing trials to validate findings.

Keywords: Planaria, Niacin, Cancer, Regeneration, Vitamin

[71] The Impact of Radiation on the Growth of Bacteria

Ishani Gupta | Adlai E. Stevenson High School

During my experiment, I tested the impact of Near Infrared radiation and Ultraviolet radiation on the growth of bacteria, *Escherichia coli*. This experiment allows one to understand if Near Infrared radiation can be used for the inhibition of bacterial growth, in a manner that is similar to the way in which bacteria is typically killed under the influence of Ultraviolet radiation. In order to perform this experiment, I exposed Near Infrared radiation and Ultraviolet Radiation to the bacteria that was streaked on 10 petri dishes. The light was exposed in a closed manner so that no other light factor was influencing the growth of the bacteria. I also used 10 petri dishes as my control group, so that I could observe and compare the bacterial growth or inhibition caused by each of the radiation to the control group. The bacteria was exposed to the radiation for 45 minutes, and then incubated overnight. After measuring the results of exposure for 45 minutes, it could be seen that the Near Infrared radiation increased the growth of the bacteria, but the Ultraviolet Radiation and control groups both did not have an impact on the bacterial growth. This is likely due to the high wavelength of NIR light, and it proves that this radiation proliferates the bacterial growth, allowing it to be used for therapeutic purposes rather than for inhibition of bacteria.

Keywords: radiation, bacterial growth, near infrared, ultraviolet, E.coli

[73] The Resistance of Cyanobacteria to Ampicillin as well as Algaecides in Order to Ascertain Impact on Growth and Subsequent Health Impacts

Aishwarya Eathara | IMSA/RISE

Recently, cyanobacterial overgrowth in ponds has become a prevalent problem, alongside the excess usage of antibiotics and algaecides that have been used to control it. Studies have shown cyanobacteria overgrowth is dangerous towards human health, and resistance to algaecide or antibiotics plays a role in causing health hazards. This experiment demonstrated growth after being exposed to algaecides and ampicillin in order to gauge how cyanobacterial resistance affected the growth. This research could be useful in determining policies to regulate algaecides and antibiotics usage to reduce resistance and understand public health implications. The initial portion of this experiment included placing *Anabaena torulosa* and *Spirulina major* into Petri dishes filled with liquid medium. Various concentrations of algaecides were used and various amounts of discs of ampicillin were placed in the dishes as separate variables, and all dishes grew under a grow light at 20°C to mimic field conditions. The second section of the experiment included measuring the growth of the cyanobacteria affected by the algaecides and ampicillin. The experimental hypothesis was supported and the null hypothesis was rejected. The statistical analyses provided evidence showing limited growth for two algaecide treatments, and higher growth for the ampicillin treatment. The cyanobacterial growth rates were linked to different treatments, the (ANOVA $p<0.0001$) value validating the experimental hypothesis. A positive impact from the results was the ability to determine future applications for safe levels of algaecides in recreational waters. This allows experts to control growth sustainably and determine critical roles that cyanobacteria play.

Keywords: antibiotic resistance, algaecide resistance, cyanobacteria, health hazards, water quality

[75] The role of the protein tyrosine phosphatase SHP-1 in TRPV1-mediated pain behavior

Kaylee Hwang | Illinois Mathematics and Science Academy

The capsaicin receptor TRPV1 is expressed in pain-sensing neurons and has been an attractive drug target for many years. However, its physiological function in regulating normal body temperature and heat sensation made TRPV1-targeting drug development challenging. Previous studies showed that the protein tyrosine phosphatase enzyme SHP-1 can modulate TRPV1 in the dorsal root ganglion (DRG) by dephosphorylation. Recently, SHP-1 has been linked to alleviating different pain phenotypes. The goal of this study was to investigate the effect of genetically enhanced SHP-1 expression on capsaicin-induced neuronal responses and pain behavior in mice. Wildtype and SHP-1 transgenic mice were used for the study. TRPV1 and SHP-1 gene expression were determined in DRG sensory neurons by RNA *in situ* hybridization. Capsaicin-induced responses of cultured DRG neurons were analyzed by *in vitro* calcium imaging. *In vivo*, acute nocifensive behavior, mechanical allodynia, and paw oedema were determined following capsaicin or vehicle paw injection. TRPV1 phosphorylation status in the DRG was determined by Western blot. SHP-1 and TRPV1 were co-expressed in a subset of DRG sensory neurons. Interestingly, capsaicin-induced neuronal responses in the DRG of SHP-1 transgenic mice were reduced. Compared to vehicle, capsaicin-induced nocifensive behavior and paw oedema without significant differences between genotypes. However, mechanical allodynia was significantly reduced in SHP-1 transgenic mice compared to wild types. TRPV1 phosphorylation was also reduced in the DRG of transgenic mice. Our results suggest that genetically enhanced SHP-1 expression modulates TRPV1 function in a modality-specific manner that might be devoid of the limiting side effects of TRPV1 antagonists.

Keywords: Pain, TRPV1, SHP-1, capsaicin

Keynote Talks - Abstracts

What Makes a Pilus? Determining the Impact of msh Genes on MSHA Pilus Production in *Vibrio cholerae*
Anindita Saha and Kyle Floyd

The aquatic bacterium, *Vibrio cholerae*, is the cause of the deadly gastrointestinal disease cholera. Each year there are ~3-5 million reported cases of cholera, resulting in ~100,000-140,000 deaths. The ability of *V. cholerae* to form multicellular biofilms is associated with its environmental survival and persistence. Most currently circulating pandemic strains of *V. cholerae*, attach to environmental surfaces and initiate biofilm formation using the type IV mannose-sensitive hemagglutinin (MSHA) pilus. Loss of MSHA pilus production results in attenuation of surface colonization and biofilm formation. Therefore, understanding the biogenesis and regulatory mechanisms that drive MSHA pilus production is vital to deciphering *V. cholerae* environmental survival. MSHA pili are encoded within two predicted genetic operons; *msh-I* (*mshHIJKLMNEGF*) and *msh-II* (*mshBACDOPQ*). Many of the *msh* genes are homologous to similar type IV pilus genes in *Pseudomonas aeruginosa* and *Myxococcus xanthus*, however, there are *msh* genes which show little to no homology. My goal is to investigate the uncharacterized components of the *msh* operons, and their contribution to *V. cholerae* surface attachment and biofilm formation. To this end, I have successfully generated in-frame marker-less deletions of each *msh* gene individually, along with complementation plasmids for each gene. Analysis of MSHA pilus production for each deletion and complementation strain, via hemagglutinin (HA) assay, have demonstrated that *msh* genes *mshI, mshJ, mshK, mshL, mshM, mshN, mshE, mshG, mshA, mshC, mshD, mshO, and mshP* are vital for MSHA pilus production. Deletion of genes *mshH*, *mshF*, *mshB*, and *mshQ* were observed to still support MSHA pilus production, suggesting these genes might play an accessory role in pilus assembly or function. Analysis of major pilin subunit (MshA) protein production via immunoblot, demonstrated similar MshA levels among each deletion mutant (except Δ*mshA*), suggesting that pilus components are produced but not assembled among these deletion mutants. Future studies will seek to supplement these observations using fluorescence microscopy for direct pilus visualization, and quantification of cell-surface pilus levels via flow-cytometry. Together, these studies will elucidate genes important for MSHA pilus production, with the aim of developing new strategies to reduced *V. cholerae* environmental survival and persistence.

Deciphering Magnetic Transduction in *C. elegans*: A Journey into Sensory Mechanisms
Aalimah Akinosho and Andrés Vidal-Gadea

Magneto-sensation, the ability to sense and use the magnetic field, is a phenomenon that is now established in many animals of various kingdoms. Although the mechanisms that magnetosensitive animals use to sense magnetic field is still an area of debate, electromagnetic induction, chemical magnetoreception, and biogenic magnetite transduction are the three major hypothetical mechanisms proposed for magnetic field detection. Our lab recently described that the nematode *C. elegans* orient to magnetic fields in a light-independent manner. *C. elegans* use a pair of poly-sensory neurons (the AFDs) associated with temperature sensation to sense magnetic forces within magnetic fields. The main aim of my thesis is to establish the mechanism by which *C. elegans* detects magnetic fields. To this end, I am investigating and testing two of the hypothetical mechanisms for magneto-sensation previously proposed- magnetocaloric and magneto-mechanic mechanism. The former involving the heating or cooling of the magnetic material when the applied magnetic field changes while the latter involves magnetic particle orientation change caused by a force produced by the presence of a magnetic field. I present evidence that different temperatures elicit different magneto-taxis responses in *C. elegans*. Understanding how *C. elegans* orients to magnetic fields will help us understand how many other species interact with the earth magnetic field. This is particularly relevant in the context of an ever-increasing list of known magneto-tacting species, and in the context of the ongoing reversal of the earth's magnetic field.

Survival of the Fittest: Deciphering pathogenic *Escherichia coli*'s increased resistance to neutrophilic antimicrobial hypochlorous acid

Sadia Sultana and Jan Dahl

The human body hosts trillions of microorganisms most of which are beneficial for our health. However, some bacterial pathogens can cause serious infections with often lasting effects for patients. Our immune system allows us to fight pathogen invasion successfully. Innate immune cells, such as neutrophils, represent the first line of defense by generating potent antimicrobials. Among those is hypochlorous acid (HOCl), which kills the phagocytosed pathogen through widespread oxidative damage. We showed evidence that contrary to intestinal *E. coli* pathotypes, uropathogenic *Escherichia coli* (UPEC), the common culprit of urinary tract infections (UTIs), are substantially more resistant to neutrophil-mediated killing and HOCl-stress. However, how UPEC copes with HOCl remains enigmatic. I identified the gene product responsible for UPEC's increased HOCl resistance: RcrB, a putative membrane protein with unknown function. We found that RcrB-deficient UPEC strains are substantially more HOCl-sensitive and succumb neutrophil-mediated phagocytosis much faster than wildtype strains, likely due to the increased degree of oxidative damage detected in rcrB-defective cells. Our goal is now to decipher the precise mechanism by which RcrB contributes to UPEC's increased HOCl resistance. Bacteria have evolved highly specific stress defenses to protect themselves from environmental threats. Thus, a better understanding of UPEC's HOCl-stress response mechanism may reveal a novel therapeutic drug target. Due to the essential role that RcrB appears to play in UPEC's HOCl resistance, the proposed study has the potential to help us better understand how UPEC persists in HOCl-rich environments such as the inflamed urinary tract.