

# Abstract: Science and Engineering Fair of Houston

**3060**

## Computational Solutions for Aducanumab and Lecanemab ARIA disposition

Varun Sangar

Clear Creek ISD /Clear Creek High School

Category:

Biochemistry and  
Microbiology

The purpose of my invented polysubstance cocktail, run through Python computational modeling, is to find a way to combat the harmful side effects of monoclonal antibodies such as aducanumab and lecanemab. Few existing drugs that mitigate ARIA avoid immune cell degradation, a precedent I aim to change through a cocktail that protects the brain while minimizing pathogen-immune cell interaction. My hypothesis was that a cocktail with complementary anti-inflammatory, BBB-targeting, and vasodilatory properties would show synergistic effects that reduce ARIA and protect the BBB. Through matplotlib modeling and a mathematical synergy formula, bar graphs representing synergy and ARIA protection were made; PyRx and other databases provided pharmacological properties that were multiplied to find ARIA reduction. After generating these graphs in Python CAD, a correlational coefficient across all trials was derived. Major quantitative findings showed one trial reaching 73.1% ARIA reduction (high BBB target), and average synergistic effects exceeded 40% each time. A cocktail producing this level of synergy while aiding the brain environment is novel, and the 0.586 correlational coefficient supports the argument that a mass-produced version could reduce ARIA risk in patients as dosage increases. In conclusion, the computational model relies on deriving component-specific pharmacological properties from databases and inputting them into formulas that numerically compare the cocktail's protection against ARIA vs. aducanumab's ARIA risk. Despite being theoretical, later studies considering physiological variation in humans could validate the universal vasodilation, anti-inflammation, and metabolite effects this polysubstance cocktail fosters.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- Human participants       potentially hazardous biological agents  
 Vertebrate animals       microorganisms       rDNA       tissue

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- yes       no

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- yes       no

4. This project is a continuation of previous research.

- yes       no

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# Abstract: Science and Engineering Fair of Houston

**3061**

## Histamine Reduction in Response to Natural Allergens

Thrayee Rao

Fort Bend ISD /Clements High School

Category:

Biochemistry and  
Microbiology

A major mediator and contributor to allergic reactions, histamine is released through exposure to natural allergens such as pollen, dust mites, and food proteins from mast cells. The overproduction of histamine is a major contributing factor to many symptoms associated with allergies, yet current over-the-counter histamine medications often come with adverse side effects and fail to target natural biological mechanisms. In order to comprehend existing scientific knowledge regarding histamine mechanisms, this project surveyed existing biochemical and microbiological studies related to histamine to discover methods upon which histamine levels or histamine responses to natural allergens could be diminished. A scientific literature review with a focus upon peer-reviewed scientific studies available as academic research databases was used to select studies for consideration, with a focus upon studies also adequately testing experimental or scientific hypotheses related to histamine regulation. These studies include biochemical studies related to histamine, such as histamine degranulation inhibition and histamine degrading enzymes, as well as related microbiological studies, such as histamine modulation related to gut microorganisms and probiotic interactions. A scientific review of these studies provides evidence of existing natural pathways related to histamine regulation, such as natural compounds, which affect histamine production and degradation levels, offering a better comprehension of existing scientific knowledge related to histamine regulation and suggesting avenues for viable scientific studies related to experimental discovery.

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# Abstract: Science and Engineering Fair of Houston

**3062**

## Paired Functional Screening to Discover Novel Membrane-Bound Receptors that Potentiate Phagocytosis

Emily Zhang, Kevin Hu

Houston ISD/DEBAKEY HIGH SCHOOL FOR HEALTH PROFESSIONS - HS

Category:

Biochemistry and  
Microbiology

Microglia are the primary immune cells in the brain, responsible for clearing pathogens and damaged cellular materials through phagocytosis. Impaired microglial phagocytosis contributes to neurodegenerative diseases and accelerates brain tumor progression, yet the mechanism regulating this process remain poorly understood. To systematically identify genes and factors that enhance microglial phagocytosis, we designed and established a novel a CRISPRa gain-of-function screening platform combined with a paired ligand-receptor validating strategy. We verified The CRISPRa screening system by flow cytometry on paraformaldehyde-fixed THP-1 cells that were transduced with CRISPRa machinery components and a gRNA targeting CD206. We then designed a paired screening approach, in which the 40 most abundantly expressed cytokines (ligands) in the brain were used to treat the THP-1 cells, while their corresponding receptors were simultaneously hyperexpressed using CRISPRa. Ligand-receptor pairs were considered hits when both ligand treatment and receptor activation significantly enhanced phagocytosis of fluorescently labeled beads. Using this strategy, we identified LPGDS (ligand)-Marcks (receptor) a novel regulator of phagocytosis. We then validated that LPGDS treatment or Markcs overexpression could significantly enhance the uptake of fluorescent dye conjugated beads with flow cytometry. To reinforce our discovery in another system, we performed the phagocytosis assay on the IMG mouse microglial cells and visualized FITC-bead uptake with confocal microscopy. We found that treatment of LPGDS could significantly enhance FITC-bead uptake in microglia. Together, our studies identify LPGDS-Markcs as a previously unrecognized ligand–receptor pair that promotes microglial phagocytosis, revealing a promising therapeutic target for neurodegenerative diseases and brain tumors.

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# Abstract: Science and Engineering Fair of Houston

**3063**

## Discovery of potential AR androgen receptor(2AM9) inhibitors from natural sources

Taiwo Iroko, Armando Flores

Harmony Public Schools - South District/Harmony School of Innovation - Sugar land

Category:

Biochemistry and  
Microbiology

My name is Armando Flores and Our project is about prostate cancer and we will be using computation screening of 200 natural organic compound from selleck chemical LLC against catalytic site of the target receptor will identify one or more novel inhibitors with stronger binding , affinity , higher specifcity and lower predicted toxcity than existing drugs.

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# Abstract: Science and Engineering Fair of Houston

**3064**

## **In Silico Evaluation of Metal–Organic Frameworks for Receptor-Mediated Drug Delivery Across the Blood–Brain Barrier, targeting Glioblastoma**

Diya Rajkumar

Katy ISD/Tompkins - HS

Category:

Biochemistry and  
Microbiology

Glioblastoma is the most common and aggressive type of malignant primary brain tumor, originating from glial cells, characterized by rapid growth, infiltration into healthy brain tissue, and often diagnosed in older adults. The blood-brain barrier is a selective barrier that protects the brain from harmful substances in the blood, allowing essential nutrients to pass while blocking toxins, pathogens, and most drugs. Metal-organic frameworks are crystalline, porous materials composed of metal ions or clusters linked by organic molecules, forming cage-like structures. The aim of the research is to computationally evaluate metal-organic frameworks as nanocarriers for receptor-mediated drug delivery across the blood-brain barrier. The three-dimensional structures of MOFs were obtained from crystallographic databases, while the ZIP protein was designed using AlphaFold. Molecular docking simulations were performed using HDock to analyze interactions between MOFs, FDA-approved neurological drugs, and target receptors. The results showed that certain MOF-drug complexes exhibited strong binding affinity, suggesting enhanced potential for BBB transport. The research aims to develop therapies that can bypass the blood-brain barrier to inhibit glioblastoma.

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# Abstract: Science and Engineering Fair of Houston

**3065**

## Discovery of Natural Compounds as a Potential Inhibitor on Rho Kinase to Cure Glaucoma

Mehmetemre Kose, Muharrem Kendirci

Harmony Public Schools - South District/Harmony School of Innovation Katy

Category:

Biochemistry and  
Microbiology

Glaucoma is a leading cause of irreversible blindness, and the overactivity of RHO Kinase plays a major role by elevating intraocular pressure. Targeting this enzyme has become a promising strategy for developing safer and more effective treatments. This project uses AutoDock Vina to virtually screen a library of natural organic compounds to identify molecules capable of binding to and inhibiting the RHO Kinase active site. By focusing on natural compounds, which often offer better safety and biological compatibility, this study aims to discover potential inhibitors that could serve as strong candidates for future glaucoma therapies.

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# Abstract: Science and Engineering Fair of Houston

**3066**

## Synthesis and Evaluation of Crosslinked Polyethyleneimine Conjugation as a Safe Gene Carrier

Alexander Gao

Conroe ISD /AST: Academy of Science and Technology

Category:

Biochemistry and  
Microbiology

Gene vectors, also called carriers, are one of the two major components to gene therapy and play a major role in the development of future treatments; it serves to package, protect and facilitate the transport of genetic material into cells. Polyethyleneimine (PEI) is one of the most widely studied nonviral gene carriers due to its high cationic charge density, which enables it to form strong polyplexes with nucleic acids and facilitate efficient cellular uptake through its electrostatic interactions with the negatively charged cell membrane. However, PEI's high charge is also associated with cytotoxicity caused by its post-delivery disruptions of cellular pathways, highlighting the importance of engineering an improved PEI-based gene carrier that balances transfection efficiency with cell viability by adjusting its charge density. In this study, I report the design of a novel PEI-Chitosan crosslinked polymer, functionalized with aldehyde and methacrylate to optimize use for plasmid transfection. Different molecular weight PEI was first tested for its base efficiency and cell viability to identify the optimal type to use for the formation of the complex. The selected MW-polymer was functionalized with aldehyde and methacrylate molecules to determine which proved most effective at reducing the complex's charge. Finally, the polymer was crosslinked with chitosan with the goal to increase biocompatibility: another downside of PEI. The complex was then employed in vitro transfer of fluorescent plasmids into a cell culture, displaying a significant increase in cell viability compared to traditional PEI while maintaining transfection efficiency.

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# Abstract: Science and Engineering Fair of Houston

**3067**

## **Silver Colloid vs. Chemical Disinfectants in the Killing of Escherichia coli**

Isaac Ortega

Private/THE JOHN COOPER SCHOOL - HS

**Category:**

**Biochemistry and  
Microbiology**

The purpose of this study is to see if silver colloid, a nanotechnology that claims to kill bacteria, can be used as a topical disinfectant. It was compared against other mainstream chemical disinfectants such as Clorox, Lysol, and hand soap to see if it was better, as good as, or worse than them in their disinfecting efficiency and efficacy in killing the bacteria Escherichia coli. Nanotechnology is a new innovation that has been claiming to be the technology of the future so it sparked my curiosity to see how it truly compared against traditional chemicals. In a Biosafety Level 1 lab, I performed my prospective study by initially autoclaving the doorhandles then innoculating them with the E. coli bacteria. I then subsequently applied my disinfectants and silver colloid to the door handle surfaces for disinfection. After this, the door handles were serially cultured at 5 minute, 2 hour, 6 hour, and 12 hour intervals. The cultures were subsequently read after 12 hour, 24 hour, 36 hour, and 48 hour incubation periods. Clorox was the only disinfectant that killed 100% of the bacteria after 5 minutes of application and remained without growth even after 36 hours of incubation. Handsoap was second best. There was no bacterial growth after 5 minutes but there was growth after 36 hours of incubation. Next was Lysol. Although it killed most of the bacteria initially, there was subsequent growth after 48 hours of incubation. Silver colloid performed the worst. It did not prevent bacteria from growing although the growth was much less than my positive control. It did seem to have some effect only after the disinfectant was applied for 12 hours. Silver colloid wasn't as effective as hypothesized. Analyzing the data above, I do not recommend Silver Colloid as a disinfectant. At its best, it only killed 50% of the bacteria after applying it for 12 hours while Clorox killed all bacteria.

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# Abstract: Science and Engineering Fair of Houston

**3068**

## **Examining the Effects of Microplastic Exposure on Beneficial Gut Microbacteria, and Determining a Possible Solution that Rejuvenates the Microbiota Post-Exposure.**

Zara Poon

Conroe ISD /AST: Academy of Science and Technology

Category:

Biochemistry and  
Microbiology

Microplastics are increasingly found in food and drinking water and have been shown to cause oxidative stress and have other negative effects on the growth of beneficial gut bacteria. This experiment investigated how microplastic exposure affects the growth of *Lactobacillus acidophilus* and other beneficial gut bacteria in a controlled, anaerobic jar environment that simulates the conditions of the large intestine. The study also examined whether vitamin C, vitamin E, or a combination of both could reduce the negative effects of microplastics on bacterial growth. The liquid cultures were prepared using organic yogurt and MRS broth and exposed to microplastic beads. Bacterial growth of the liquid cultures was measured using a spectrometer, which measures optical density, every 30 minutes. Results showed a decrease in bacterial growth after microplastic exposure. The addition of vitamin C led to a noticeable revival in bacterial growth, while the combination of vitamin C and vitamin E did not improve growth beyond vitamin C alone. A one-way ANOVA statistical test indicated significant differences in the bacterial growth. These findings suggest that microplastics negatively impact beneficial gut bacteria and that vitamin C may help restore bacterial growth after microplastic exposure.

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# Abstract: Science and Engineering Fair of Houston

**3069**

## **Novel In-Silico Rational Design of a Hyper-Thermostable Chimeric PETase via Rigid Alpha-Helical Linker Fusion for Enhanced Industrial Plastic Depolymerization**

Aryan Atri, Amarechi Okorafor, Ayushmaan Singh

Cypress Fairbanks ISD/Bridgeland - HS

Category:

Biochemistry and  
Microbiology

The accumulation of Polyethylene Terephthalate waste poses a critical environmental challenge yet enzymatic recycling remains industrially unviable due to the thermal instability of the wild-type Ideonella sakaiensis PETase. While IsPETase degrades plastic, it denatures at 40 degrees Celsius which is well below the 70 degrees Celsius glass transition temperature where polymer chains become mobile and accessible. We engineered a novel chimeric enzyme to bridge this gap by fusing the hyper-thermostable Sac7d domain to IsPETase using a rigid alpha-helical linker. This design contrasts with traditional flexible linkers which often lead to entropic domain collapse at high temperatures. We used AlphaFold2 for structure prediction and GROMACS for Molecular Dynamics simulations to subject the novel construct to industrial reactor conditions at 343 Kelvin. The simulation results demonstrated that the rigid linker successfully maintained structural stability where the wild-type and flexible-linker variants failed. A Techno-Economic Analysis performed in DWSIM revealed that operating at the polymer's glass transition temperature reduces the required reaction time by 10 times. The six-tenths rule indicates this efficiency gain allows for a 90% reduction in reactor volume which translates to a 75% reduction in capital expenditures. This study presents the first computational blueprint for a rational design strategy that overcomes the glass transition barrier to enable diverse industrial applications and establishes a superior cost-competitive alternative to mechanical recycling.

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# Abstract: Science and Engineering Fair of Houston

**3070**

## Intestinal Microbiome Variations in Pediatric Crohn's Disease Patients

April Guo

Private/Awty International School

Category:

Biochemistry and  
Microbiology

Intestinal microbial populations constitute a complex biological system that influences immune function. Their imbalance, or dysbiosis, appears connected to inflammatory bowel conditions like Crohn's disease (CD). While dysbiosis patterns in adult CD patients have received substantial attention, similar conditions among children remain comparatively understudied. This investigation examined compositional modifications within pediatric CD intestinal microbiomes using publicly available sequencing data. I conducted a systematic reanalysis of 16S rRNA genetic sequencing data using 43 pediatric fecal samples obtained from the iHMP database, including 21 sick and 22 healthy controls. Computational procedures were conducted inside MicrobiomeAnalyst 2.0. Analytical components included: within-sample microbial diversity assessed using the Shannon index with comparisons conducted through Welch's t-test; between-sample community dissimilarity calculated using Bray-Curtis distance matrices, visualized through PCoA and evaluated using PERMANOVA; and identification of bacterial divisions using EdgeR. Results showed a reduction in within-sample microbial diversity in CD subjects compared to healthy controls. Between-sample diversity analysis revealed clear separation between groups in multivariate space, indicating distinct microbial community structures. Differential abundance analysis identified compositional differences, with Firmicutes and Actinobacteria reducing while Proteobacteria and Fusobacteria increased. These compositional shifts are consistent with established markers of inflammatory microbial dysbiosis. This investigation confirms substantial intestinal microbiome dysbiosis in pediatric Crohn's disease, characterized by diminished microbial diversity, reorganized community architecture, and specific phylogenetic disproportions. The outcomes highlight how public databases can be used for research and theoretical development.

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# Abstract: Science and Engineering Fair of Houston

**3071**

## Stressing Cells

Sodana Oun

Pasadena ISD/Pasadena Memorial High School

Category:

Biochemistry and  
Microbiology

The basis of my project was originally to measure oxidation rates in energy drinks only, however I decided to expand on that idea and include 2 more forms of caffeine: green tea and black coffee. The goal of my project is to determine which source of caffeine affects oxidation rates more, with my hypothesis expecting energy drinks to affect it the most. In my research, temperatures and pH for both green tea and coffee seemed to follow the control, with the energy drink being the oddball of the experiment. This meant that my hypothesis was likely correct. Simple information about oxidation will be presented on my board, with it's connections from apples to humans being described as the core of my project. I want my project to mirror that of a human as accurately as possible.

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# Abstract: Science and Engineering Fair of Houston

**3072**

## Computational Identification of Flavonoid-Based CCR4 Antagonists Using Molecular Docking In the Context of Cancer Immunosuppression

Kendrick Toennies

Clear Creek ISD /Clear Brook High School

Category:

Biochemistry and  
Microbiology

Cancer is the second leading cause of death in the United States; in 2025, an estimated 626,000 people will die from cancer. Effector immune cells should attack cancer cells, but are often suppressed by T regulatory (Treg) cells. Activated Tregs express anti-inflammatory cytokines which suppress immune response. Tregs move through the body via positive chemotaxis, in which the chemoattractant CC chemokine ligand 22 (CCL22) binds to CC chemokine receptor type 4 (CCR4) and directs Treg migration toward sites of expression. Tumors overexpress CCL22, thus recruiting Tregs and suppressing immune responses. The goal of this project was to identify potential organic antagonists of CCR4 using SwissDock, determine the relevant biochemical features that enable this antagonism, and assess the molecules' potentials as drug candidates. CCR4 predicted structure was retrieved from AlphaFold3. Flavonoids were chosen due to their diverse functional groups and empirical evidence of CCR4-flavonoid interactions, and ligands were selected based on hydroxylation, methoxylation, and glycosylation (for size). All ligand structures and properties were retrieved from ChEMBL. Chrysin was determined to have an optimal ligand efficiency (441.3 kcal/NHA) and polar surface area near the ideal 60-70 Å<sup>2</sup> range (70.67 Å<sup>2</sup>). The binding site of high-performing poses were located in the same pocket, all binding to Tyr-191. Further in-silico studies will evaluate the subtype selectivity across a panel of chemokine receptors to ensure target-specific antagonism and minimize potential off-target effects. Once computationally predicted candidacy is confirmed, in-vitro studies will confirm Treg migration inhibition through migration assay.

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# Abstract: Science and Engineering Fair of Houston

**3073**

## Composition of Plastics, Save the Planet from the source of dehabitation

Anupama Teki, Sahithi Kommuri

Fort Bend ISD /Clements High School

Category:

Biochemistry and  
Microbiology

This project explores the impact of additives on the degradation rate of bio-based plastics, with the goal of creating a faster-degrading material suitable for educational purposes. We will use natural resources of glycerol to conduct our experiment. Each bioplastic with glycerol will be put in different environments with different trials and be analyzed at the end.

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# Abstract: Science and Engineering Fair of Houston

**3074**

## Proteomics-Driven Metabolic Modeling Reveals NDI1 Bypass as a Possible Strategy to Combat Muscle Weakness

Liv Yang

Fort Bend ISD /Dulles High School

Category:

Biochemistry and  
Microbiology

Down syndrome (DS) is the most common genetic cause of intellectual and developmental disability. Individuals with DS exhibit significant physical weakness, the mechanisms for which are severely understudied. Proteomic analyses of skeletal muscle from DS and wild-type mice at postnatal day 14 (P14) and 4 months (4M) revealed progressive alterations in mitochondrial protein expressions, indicating early deficits in oxidative phosphorylation (OXPHOS) might contribute to the physical disability in DS. To explore this mechanism, MitoCore, a constraint-based computational model of human metabolism, was used to integrate proteomic data and identify ATP production bottlenecks in silico. At P14, reductions in Complex I (CI) core and accessory subunits impaired NADH oxidation and reduced Complex V (CV) flux, indicating decreased ATP-generating capacity. By 4M, protein dysfunction was substantially increased. Simulated introduction of NDI1, an alternative electron entry into the electron transport chain, tested at 50%, 75%, and 100% of lost CI capacity, increased CV flux by roughly 7%, 14%, and 19%, respectively, though full recovery was limited by lack of proton gradient contribution. Together, these findings indicate that ATP deficits arising from early mitochondrial dysfunction might contribute to muscle development and the muscle weakness later in life in DS. This project demonstrates that integrative in silico modeling can aid in assessing potential rescue strategies using results generated through proteomic screening, while highlighting the need for experimental validation of mitochondrial flux, ATP production, and protein function.

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- yes       no



# Abstract: Science and Engineering Fair of Houston

**3075**

## Halting Hepatic Steatosis in Non-Alcoholic Fatty Liver Disease: An In Silico–Ex Vivo Pipeline for Discovering Phytochemical Modulators

Moemal Al-Wishah, Ali Moualla

Private/British International School Houston - HS

Category:

Biochemistry and  
Microbiology

Non-alcoholic fatty liver disease (NAFLD) is the most prevalent global chronic liver disorder, characterized by hepatic lipid accumulation and mitochondrial oxidative stress; however, it remains without FDA-approved pharmacological treatments. This research utilized a multi-scale drug discovery pipeline to identify and validate high-affinity phytochemical modulators of De Novo Lipogenesis (DNL) and antioxidant pathways. Initially, a library of flavonoids and alkaloids was screened via AutoDock Vina against 12 metabolic targets; Quercetin (ACACA: -8.7 kcal/mol) and Baicalein emerged as primary leads with zero Lipinski violations. To validate clinical relevance, human liver transcriptomic datasets (GEO) were analyzed via Volcano Plots and Heat Maps to confirm clinical over-expression of identified targets. Wet-lab validation was conducted using a BSL-1 biological model. Quercetin and Baicalein were organically synthesized via ethanol extraction from *Allium cepa* and *Scutellaria baicalensis*, respectively. The hepatoprotective efficacy of this dual-phytochemical formulation was quantified through catalase activity assays on avian hepatic tissue. Finally, a Genome-Scale Metabolic Model (GEM) utilized Flux Balance Analysis (FBA) to simulate a steatotic state. Applying phytochemical constraints predicted a 58% reduction in intracellular triglycerides and a restoration of redox balance. This study provides a computationally discovered and ex vivo validated framework for the synergistic treatment of NAFLD using natural flavonoids.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- Human participants       potentially hazardous biological agents  
 Vertebrate animals       microorganisms       rDNA       tissue

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# Abstract: Science and Engineering Fair of Houston

**3076**

## Computationally Exploring Correlations Of NOS2 And TP53 To Support NOS2 Effects On Survival

Ishan Pinjala

Conroe ISD /AST: Academy of Science and Technology

Category:

Biochemistry and  
Microbiology

Glioblastoma is a challenging tumor to tackle due to its resistance to conventional therapies. This experiment investigates the potential of NOS2 as a therapeutic target by examining its relationship with TP53, a tumor suppressor. Since NOS2 derived nitric oxide can influence TP53 activation, it can be hypothesized that NOS2 expression correlates with patient survival and differs in normal and tumor samples. The experiment utilized RStudio, Cygwin for terminal integration, and UCSC Xena's Kaplan-Meier plotter with publicly available data from the TCGA-GBM Project. Code was developed to compile, harmonize and visualize gene expression patterns. Results reveal unexpected findings: in tumor patients, there was a 0.09764 correlation coefficient for NOS2 and TP53, but normal samples showed an -.8731 correlation between NOS2 and TP53. The strong data in the normal sample can be explained by size, but the Kaplan-Meier plot showed overlapping lines for high NOS2 (red) and low NOS2 (blue) expression, indicating no significant relationship in NOS2 expression and patient survival. The mixed results suggest NOS2 functions better as an important biomarker for TP53 over a direct link for TP53 activation and survival. Despite methodological limitations, the study shows potential for large scale tumor analysis. With refined methodologies and enhanced computational approaches, it could be easier to demonstrate NOS2's influence on glioblastoma patient outcomes.

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# Abstract: Science and Engineering Fair of Houston

**3077**

## **Disrupting Tumor Blood Supply: Computational Designing of Ankyrin Repeat Proteins (DARPin)s and Antibodies Targeting Endosialin for CAR-T Therapy**

Asha Dimino

Private/Fusion Academy Galleria Houston

Category:

Biochemistry and  
Microbiology

CAR-T cell therapy is an innovative cancer treatment that uses a patient's own immune cells to recognize and destroy cancer cells. While this therapy has been successful in treating blood cancers, it has been less effective against solid tumors such as breast cancer. One major challenge is identifying cancer-specific targets that do not harm healthy cells. In this project, the protein endosialin, which is highly expressed on blood vessels that supply solid tumors, was investigated as a potential target for breast cancer therapy. Computational methods were used to study endosialin and HER2 proteins. Protein sequences were obtained from UniProt, and three-dimensional structures were generated using AlphaFold 3. Protein localization and membrane orientation were analyzed using the Human Protein Atlas and PROTTTER. Molecular docking simulations were performed to evaluate the binding of antibodies and DARpins to endosialin, followed by molecular dynamics simulations to assess the stability of these interactions over time. Binding energy calculations were used to compare interaction strength. The results identified antibodies and DARpins that showed strong and stable binding to endosialin, suggesting their potential use in CAR-T cell therapy targeting tumor blood vessels. This approach may reduce nutrient supply to tumors and inhibit cancer growth. These findings support endosialin as a promising target for future CAR-T cell therapies in breast cancer and other solid tumors.

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# Abstract: Science and Engineering Fair of Houston

**3078**

## **Computational Identification of Candidate PARP-1 (3L3M) Inhibitors from Natural Compounds for BRCA1/2-Mutated Ovarian Cancer**

Roshanay Khan, Eshal Khan

Harmony Public Schools - South District/Harmony School of Innovation - Sugar land

Category:

Biochemistry and  
Microbiology

Ovarian cancer is a leading cause of cancer related mortality among women, with BRCA1/2 mutations contributing to damaged DNA repair mechanisms. PARP inhibitors are targeted cancer therapies that exploit defects in DNA repair pathways, particularly in BRCA1/2-mutated cancers. Because of this, we aimed to identify potential PARP1 inhibitors from natural compounds using computer based analysis. The known structure of the PARP1 protein served as the target, and we tested 200 naturally derived compounds for their ability to bind to the protein. The compounds were then ranked according to their predicted binding strength. Of these, fifteen showed the strongest interactions with PARP1. Notably, natural compounds such as dioscin, epigallocatechin gallate, hesperidin, gypenosides, ginkgolide B, and triamcinolone emerged as promising candidates. Our results suggest that some natural compounds may interact effectively with PARP1. The findings demonstrate that computer modeling is a useful first step for identifying potential PARP inhibitors relevant to BRCA1/2-mutated ovarian cancer.

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# Abstract: Science and Engineering Fair of Houston

**3079**

## **In Silico Design and Computational Modeling of Ribonuclease-Targeting Chimeras (RiboTACs) for RNA Degradation Pathways in Parkinson's Disease**

Neel Heblkar

Fort Bend ISD /Dulles High School

**Category:**

Biochemistry and  
Microbiology

Parkinson's disease (PD) is the fastest-growing neurodegenerative disorder, affecting more than 10 million individuals worldwide. Current treatments are largely symptomatic and fail to address the molecular framework driving disease progression, notably the dysregulated post-transcriptional control of  $\alpha$ -synuclein (SNCA), the primary PD biomarker. The experiment presents a novel in-silico framework regarding the implementation of Ribonuclease-Targeting Chimeras (RiboTACs) for selective degradation of disease-causing RNA in PD. The iron-responsive element (IRE) within  $\alpha$ -synuclein mRNA was selected as the therapeutic target due its regulatory role in protein expression, alongside structurally distinct molecular scaffolds of 5 RiboTAC candidates. Ribonuclease L (RNASEL) tertiary structures were generated using deep learning-based architectures, while thermodynamically stable binding conformations of the single-stranded IRE RNA sequences were predicted using Minimum Free Energy (MFE) analysis. Structural convergence metrics, including Root Mean Square Deviation (RMSD) and base-pairing probability heatmaps were utilized to identify stable and recurrent RNA regions, as well as confirm reliability and consistency. Functionally relevant RNA-binding and catalytic surface pockets located on RNASEL were evaluated using geometric deep-learning models; molecular docking simulations (MDS), performed using HDock, evaluated binding within the RNA-RNASEL-RiboTAC complex; binding conformations and docking scores were compared to determine complexes with the highest stability, and the top-ranked docking pose was identified with a binding energy of -2748.56 kJ/mol. ADMET (Absorption, Digestion, Metabolism, Excretion and Toxicity) analysis revealed favorable pharmacokinetic properties, including minimal hERG inhibition, oral bioavailability and negative AMES Mutagenicity. The predicted safety profile supports the ability for future in-vitro/vivo experimental validation of the compound.

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# Abstract: Science and Engineering Fair of Houston

**3080**

## **Inhibition of the Pathological PrP-Sho Complex: A Novel Therapeutic Intervention for Preventing Progression of Environmental Lead (Pb)-Induced Parkinsonism**

Sanjan Sarang

Conroe ISD /AST: Academy of Science and Technology

**Category:**

**Biochemistry and  
Microbiology**

The incidence of Parkinsonism, a movement disorder often caused by Parkinson's Disease, has doubled since 2000, affecting over 10 million individuals worldwide. A notable contributor to this rise is environmental lead (Pb) overexposure, which can induce Parkinsonism and exacerbate other movement and cognitive disorders, as seen in recent cases such as the Flint, Michigan water crisis. Currently, there is a limited understanding of Pb-induced Parkinsonism and no viable, low-cost therapeutic. This study aimed to identify the molecular mechanisms by which Pb disrupts cellular function and develop a targeted intervention to inhibit pathological protein interactions. RNA-sequencing of human neural progenitor cells exposed to 3, 30, and 100 micromolar Pb for 26 days was accessed from the Gene Expression Omnibus; key differentially expressed genes and molecular pathways were identified as statistically significant ( $p < 0.0005$ ). Pb initially displaced Zn at Zn binding sites; thus, metallothionein proteins increased ~60-fold in expression to sequester accumulating cellular Zn. Chronic Pb exposure then triggered sustained co-upregulation of Prion Protein (PrP) and Shadow of Prion Protein (Sho) complex formation, disrupting normal PrP-mediated metal efflux and leading to alpha-synuclein aggregation and Parkinsonism pathology. Identification of this detrimental PrP-Sho interaction informed the structure-based drug screening of small-molecule inhibitors, which yielded a lead candidate with -8.2kcal/mol binding energy and relevant chemical bonding with the complex. Pharmacokinetics and drug-likeness analysis indicated favorable oral drug properties to prevent PrP-Sho interaction and restore normal metal handling. These discoveries culminated in Prionguard, a first-in-class blood-brain barrier-permeable therapeutic that can prevent progression of Pb-induced Parkinsonism.

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# Abstract: Science and Engineering Fair of Houston

**3081**

## Antibiotic Properties of Plants Used In Traditional Medicine

Breydie Rosales, Sophia Nguyen

Harmony Public Schools - South District/Harmony Science Academy-Houston

Category:

Biochemistry and  
Microbiology

Traditional Eastern medicine has long used plant-based remedies to treat illness. This project investigated whether plants commonly used in Traditional Eastern medicine have antimicrobial properties that can inhibit bacterial growth. Extracts were prepared from goji berries, jujubes, pomegranate peel, and bitter melon using 70% ethanol. A non-pathogenic bacterial strain approved for student laboratory use was cultured on agar plates, and paper disk diffusion tests were used to observe zones of inhibition. An ethanol-only disk was used as a control. The zones of inhibition were measured and compared to determine the effectiveness of each plant extract. The results showed that some plant extracts produced greater inhibition of bacterial growth than others, suggesting that certain medicinal plants may contain compounds with antibacterial properties. This study supports further investigation into plant-based alternatives for combating bacterial growth.

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# Abstract: Science and Engineering Fair of Houston

**3082**

## **Pulse Frequency and Duty Cycle as Determinants of UV-C— Induced DNA Damage—Repair Balance in E. coli Under Constant Fluence**

Emmanuel Brown, Mustafon Tursunbadalov, Muhammadjon Tursunbadalov  
Charter/SST - Champions College Prep - HS

Category:

Biochemistry and  
Microbiology

This experiment investigated the efficacy of ultraviolet (UV) radiation as a sterilization method by measuring its impact on the growth of Escherichia coli (E. coli) K-12. While most E. coli strains are commensal, pathogenic varieties necessitate effective control measures to prevent foodborne illness. Using a UV sanitizer closet, agar plates were inoculated with E. coli and subjected to varying durations of exposure. Control and short-exposure groups exhibited heavy bacterial growth after 24 hours of incubation. In contrast, plates exposed to UV radiation for 60 to 90 seconds demonstrated a significant reduction in viability, yielding very few colonies. These results support the hypothesis that prolonged UV exposure induces critical DNA damage, specifically through the formation of thymine dimers, which inhibit DNA replication and microbial reproduction. The findings confirm that UV radiation is a highly effective mechanism for reducing bacterial populations.

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# Abstract: Science and Engineering Fair of Houston

**3083**

## HIV/AIDS AIDS Acquired Immunodeficiency Syndrome-HIVRT - HIV reverse transcriptase-3LAN

Kolade Durodola, Ivan Nguyen

Harmony Public Schools - South District/Harmony School of Innovation - Sugar land

Category:

Biochemistry and  
Microbiology

This project hypothesizes that If 200 natural active organic compounds are computationally screened against the target receptor, then it is expected that new potential inhibitors will show stronger binding affinity, higher specificity, so these compounds could serve as novel, effective, and safer drugs for treating the disease. Computational screening of 200 natural organic compounds from Selleck Chemical LLC against the catalytic (active) site of the target receptor will identify one or more novel inhibitors with stronger binding affinity, higher specificity, and lower predicted toxicity than existing drugs. Our top 2 molecules include: Molecule 1 Docetaxel which is a chemotherapy drug derived from a natural compound. It is created from a precursor extracted from the needles of the European yew tree (*Taxus baccata*). Molecule 2 Paclitaxel is a natural compound originally isolated from the bark of the Pacific yew tree (*Taxus brevifolia*) and is now a widely used anti-cancer drug. Based on our results the first step will be to purchase the best 15 potential inhibitors (natural organic compounds) from Selleck Chemical LLC, Houston, Texas—selected from the binding affinity list (our table)—and subsequently test them using the purchased enzyme activity assay kit.

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# Abstract: Science and Engineering Fair of Houston

**3084**

## Hunting the Pathway: Mechanistic Insights into Silver Thiosulfate-Induced Disulfidptosis in Lung Cancer

Sujit Vadlapatla, Shreyas Sarva Bishnu

Clear Creek ISD /Clear Lake High School

Category:

Biochemistry and  
Microbiology

Lung cancer today is the second most common type of cancer found in men and women, especially in the United States. Additionally, it is known to be a major cause of death annually. In our experiments, we examined whether disulfidosis was induced by silver thiosulfate (STS), which is a putative chemotherapy drug, induced cytotoxicity through disulfidptosis in the A549 human lung cell line. To determine overall cytotoxicity, cell viability was measured, and actin oligomerization was assessed as a marker for disulfidptosis. Although there was a decline in cell viability after STS exposure, we saw that disulfidptosis was not evident in any of the treatments performed as evidenced by a lack of actin stabilization by disulfide bonds. This indicated that STS does not induce cell death through disulfidosis in the A549 cell line. Because of this, to properly identify the process that was involved, additional studies are essential to discover STS's actual mechanism of cytotoxicity. By doing so, studies can reveal the drug's therapeutic potential in targeting lung and various other cancers. To sum it up, we can conclude that cytotoxic stress in lung cancer cells is generated from STS from our experimentation, which is not through disulfidptosis. To properly determine the precise cell death and evaluate if the mechanism can be exploited so that only cancerous tissues are targeted and not the healthy cells, through chemotherapy strategies, future studies and investigations are crucial.

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# Abstract: Science and Engineering Fair of Houston

**3085**

## Point of Impact: How Reusing Lancets Affect Microbial Growth

Sarah Bui

Alief ISD/Alief Early College

Category:

Biochemistry and  
Microbiology

In today's world, little scientific evidence proves that reusing lancets increases the risk of infection. Despite professionals claiming that it is dangerous, more than 65% of diabetics reuse their lancets daily, adamant that it poses little to no harm. Unfortunately, the significance of reusing lancets is unclear to the hundreds of millions of diabetics worldwide. Furthermore, this experiment hopes to offer clarity amidst such confusion. My hypothesis is, "If the lancet is used multiple times, then there will be more yeast colonies regardless of sterilization." I tested this by dipping lancets in a yeast solution, pricking them into an orange 2, 3, and 4 times, and then swabbing them onto petri dishes. Additionally, I repeated this process with alcohol sterilized lancets, simulating both sterilized and unsterilized conditions. After a week of incubation and analysis, the non-sterilized lancets displayed exponential growth, with the highest being 3cm<sup>2</sup> of coverage and an uncountable number of colonies. In contrast, the sterilized lancets had significantly less growth, disproving my hypothesis. However, yeast still appeared after sterilization, reinforcing that reusing lancets isn't completely safe. Ultimately, individuals should not reuse lancets and replace them frequently to avoid rapid bacterial buildup. If reuse is inevitable, sterilization is highly recommended to reduce the risk of infection. Overall, this study solidifies that lancets should be single-use, but also sheds light on how to mitigate the potential risk of microbial accumulation.

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# Abstract: Science and Engineering Fair of Houston

**3086**

## Investigating the Extent of Anti-inflammatory and Antioxidant Effects of Ink from Decapodiformes in Different Environmental Conditions

Benjamin Zhou, Isabella Wong, Zara Arsiwala

Conroe ISD /AST: Academy of Science and Technology

Category:

Biochemistry and  
Microbiology

Two major pathophysiological processes, inflammation and oxidative stress, play major roles in chronic diseases such as cancer, cardiovascular diseases, and neurological diseases, with approximately 34.6% of adults in the U.S. having systematic inflammation with oxidative stress significantly driving it. Previous studies have suggested ink from Decapodiformes, also known as squid, could contain anti-inflammatory and antioxidant properties, which slows inflammation and oxidative stress. Therefore, in this project the extent of squid ink's anti-inflammatory and antioxidant properties were tested in two different pH conditions, with the hypothesis being that the ink from Decapodiformes will hold higher anti-inflammatory and antioxidant properties in a higher pH condition. The pH's tested were 7.4, to model physiological conditions, and 6.8, to represent mildly acidic biological environments. To test the anti-inflammatory and antioxidant properties, the egg albumin assay and DPPH assay were performed on the ink samples, a positive control (Vitamin C) and a negative control (distilled water). The results showed that the ink with pH of 7.4 showed significant anti-inflammatory activity as it had a percent inhibition above 50% while the ink with pH of 6.8 showed significant antioxidant activity as it had a percent radical scavenging above 50% which proves the hypothesis wrong as the ink with a higher pH had a higher anti-inflammatory activity compared to the lower pH, but had lower antioxidant activity. This project could propose squid ink as a source for medicinal compounds, dietary supplements, topical creams or gels, cosmetic products, and food safety products.

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# Abstract: Science and Engineering Fair of Houston

**3087**

## **Decoding Cognitive Decline: A Multimodal AI Approach to Distinguishing Alzheimer's Disease, Dementia with Lewy Bodies, and PSP Using Tau Oligomers**

Shreyan Shah, Pavan Patel

Fort Bend ISD /Clements High School

**Category:**

**Biochemistry and  
Microbiology**

Neurodegenerative diseases affect over 55 million people worldwide, but accurately distinguishing Alzheimer's disease ( AD ), dementia with Lewy bodies ( DLB ), and progressive supranuclear palsy ( PSP ) remains a major challenge, with misdiagnosis rates approaching 30% due to overlapping clinical symptoms and limited disease-specific biomarkers. Recent biochemical studies suggest that distinct tau protein polymorphs can be used to differentiate between neurodegenerative diseases, but the complexity of tau experimental data limits interpretation using traditional analysis methods. In this study, quantitative structural and morphological tau features extracted from previously collected, de-identified experimental data were analyzed. Several machine-learning models were evaluated alongside a self-designed ensemble framework, NeuroFoldNet, which achieved a mean classification accuracy of 97.96% under K-fold cross-validation. Feature importance analysis showed that a small number of tau structural measurements consistently drove correct disease classification, indicating that specific tau features, such as morphology and signatures of tau polymorphs, may have greater diagnostic relevance than others. This work introduces a scalable computational approach for interpreting complex tau polymorph data, enabling clearer identification of disease-relevant tau features. By highlighting which tau structures are most informative, this research addresses current limitations in neurodegenerative disease classification and lays the groundwork for future biomarker-driven studies aimed at improving diagnostic accuracy. This innovation challenges current approaches to neurodegenerative disease differentiation. Global misdiagnosis rates show that over 15 million individuals may be incorrectly classified, underscoring the urgent need for machine-learning-assisted, biomarker-driven diagnostic tools like NeuroFoldNet.

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# Abstract: Science and Engineering Fair of Houston

**3088**

## Self-Healing, Conductive Hydrogel Interfaces for Long-Term Bioelectronic Skin Devices

Amanya Reddy Gottam, Aarushi Asundi

Conroe ISD /AST: Academy of Science and Technology

Category:

Biochemistry and  
Microbiology

Wearable bioelectronic devices are used for health monitoring, but many current flexible electronic materials suffer from poor durability, limited self-healing ability, and loss of electrical conductivity under mechanical stress. This project investigated whether a dual-network hydrogel combining the conductive polymer PEDOT:PSS with ionically crosslinked sodium alginate could achieve high electrical conductivity, rapid self-healing, and long-term stretch durability suitable for wearable applications. The hydrogel was synthesized by dissolving sodium alginate in distilled water, followed by the addition of glycerol and PEDOT:PSS. Genipin was used as a chemical crosslinker, while an ascorbic acid and hydrogen peroxide solution initiated polymerization. After molding, the hydrogel was ionically crosslinked by soaking in a calcium chloride solution. Mechanical self-healing was tested by cutting samples and measuring tensile recovery after 2, 5, and 10 minutes. Electrical conductivity was measured using a digital multimeter before and after damage, as well as during cyclic stretching tests up to 200 cycles. The hydrogel demonstrated adequate self-healing, achieving around 40% mechanical strength recovery within 10 minutes. Conductivity measurements showed minimal loss after healing and less than 15% conductivity reduction following repeated stretching cycles. Microscopic observation revealed limited cracking or structural damage after long-term mechanical testing. Overall, this experiment achieved the goals of maintaining conductivity, the ability to self-repair once damaged, and showed sufficient mechanical durability simultaneously.

1. As a part of this research project, the student directly handled, manipulated, or interacted with (check all that apply):

- Human participants       potentially hazardous biological agents  
 Vertebrate animals       microorganisms       rDNA       tissue

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- yes       no

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- yes       no

4. This project is a continuation of previous research.

- yes       no

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- yes       no



# Abstract: Science and Engineering Fair of Houston

**3089**

## **Caffeine-Taurine Synergy: Energy Drink Effects on Planarian Regeneration**

Amina Adamu

Clear Creek ISD /Clear Creek High School

Category:

Biochemistry and  
Microbiology

The goal of this experiment was to see whether caffeine and taurine, energy drink components, have stronger negative effects on planarian regeneration when combined than when used individually. Planarians rapidly regrow structures and are sensitive to chemicals. After pilot studies determining the LC50 for the energy drink, a .1% concentration was chosen. The planarians were amputated and assigned to 5 groups: control, Energy Drink, caffeine, taurine and caffeine + taurine. Regeneration was measured by calculating the blastema area and behavior was measured through morbidity assessments and head flip tests. The results showed that the combination of caffeine and taurine slowed regeneration the most, while the energy drink showed the most. Blastema area increased in all over time, but the caffeine led to the most inhibition as an isolated ingredient. These results show that caffeine and taurine may have synergistic effects, and since energy drinks are so widely consumed, the formulas used should be observed.

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# Abstract: Science and Engineering Fair of Houston

**3090**

## **Developing a Non-Surgical Cataract Treatment: The In Vitro Efficacy of Phosphatidylcholine in Dissolving Hen Egg White Lysozyme Aggregates**

Ellaine Ye

Conroe ISD /AST: Academy of Science and Technology

Category:

Biochemistry and  
Microbiology

Cataracts is a disease characterized by the clouding of the clear lens of the eye due to the crystalline proteins denaturing and aggregating. These aggregates cause light to scatter as it enters the eye, causing blurred vision and, in some cases, blindness. Currently, the only valid treatment for cataracts is surgery, where the lens of the eye is cut out and replaced with an artificial lens. Studies have found rosmarinic acid, a polyphenol compound, as a potential topical treatment, but it does not have the high amphiphilicity required for permeation of the eye lens. This experiment investigated phosphatidylcholine, a polyphenol compound with high amphiphilicity, in its ability to dissolve hen egg white lysozyme aggregates as a model for the crystalline aggregates in cataracts. The phosphatidylcholine was compared to sodium dodecyl sulfate as a positive control and phosphate-buffered saline as a negative control. The hypothesis was that the phosphatidylcholine would be able to effectively dissolve the aggregates. I let the treatment and controls incubate for 48 hours while recording visible aggregate height and absorbance using a PASCO spectrometer. After the 48 hours, I used the absorbance data to calculate the percent dissolution and performed individual t-tests. While the phosphatidylcholine did have a lower final absorbance and aggregate height and a higher percent dissolution from the negative control, it was not a significant difference. On the other hand, the phosphatidylcholine was significantly different from the positive control. This shows that phosphatidylcholine was not effective in dissolving the aggregates and disproves the hypothesis.

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# Abstract: Science and Engineering Fair of Houston

**3091**

## Waste To Watts

Bella Douglas, Joshua Wallace, Oliver Uribes

Conroe ISD /ASHP: Academy for Science and Health Prof

Category:

Biochemistry and  
Microbiology

This research addresses a critical vulnerability in our cities: the dependency of wastewater treatment facilities on consistent electrical power. During natural disasters or grid failures, power outages can rapidly lead to catastrophic backups of untreated wastewater, creating environmental hazards and public health emergencies. Our innovative approach leverages genetically modified E. coli to transform this challenge into an opportunity for resilience. By genetically modifying E. coli strain Crooks with new genes to enhance electron transfer capabilities, a system that can essentially function as a biological backup generator within wastewater treatment plants will be created. During power outages, these engineered microbes can metabolize organic waste components that are typically filtered out, generating sufficient electricity to maintain critical treatment operations while the main power supply is compromised. Current backup systems for wastewater facilities rely heavily on fossil fuels, are costly to maintain, and often have limited runtime during power outages. Our microbial fuel cell (MFC) approach provides a sustainable alternative that actually uses the wastewater itself as fuel, creating a circular system where the problem becomes part of the solution.

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# Abstract: Science and Engineering Fair of Houston

**3092**

## The Generational Makeup Gap: A Comparative Study of Bacterial Presence on Makeup Tools Across Age Groups

Leire Vail, Ella White, Charly Lemmon

Conroe ISD /ASHP: Academy for Science and Health Prof

Category:

Biochemistry and  
Microbiology

Teens are constantly trying to figure out the reason behind acne. Is it stress? Hormones? Diet? Bacteria can constantly be exposed to young girls' faces through the use of makeup applicators. After analyzing the bacterial growth of the two most common makeup applicators (beauty blender/brush), it was determined that brushes harbor more bacteria and were correlated with applicant users who were higher on the rubric scale. Although this was the end result, some brush users didn't have much bacteria on the applicator but still had severe acne. However, with this certain age group, it's well known that hormones are at a high. In order to get rid of the suspected hormonal factor, women over the age of 50 were asked to participate in this project since after menopause, hormones are more balanced. Tests were run on the women's applicators in increments of 24 and 48hrs. In the end, brushes harbored the most bacteria, but in the older women, their skin was lower on the scale and not as severe as the teen girls. It was concluded that brushes still harbored more bacteria, but also that the skin characteristics of the teen girls were heavily skewed based on other factors.

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# Abstract: Science and Engineering Fair of Houston

**3093**

## Investigating How Inulin Affects the Growth Rate and Biofilm Activity of *Lactobacillus crispatus*

Mahika Pakal

Private/THE JOHN COOPER SCHOOL - HS

Category:

Biochemistry and  
Microbiology

Inulin is a plant-derived fiber that is metabolized by *Lactobacillus crispatus* (LC), the dominant bacterial species in the vaginal microbiome. Inulin stimulates LC to produce lactic acid, a “postbiotic” that helps maintain the acidic pH needed to protect the vaginal epithelium from pathogenic bacteria, viruses, and fungi. LC is essential for microbiome stability, and its population is a key indicator of vaginal health. When LC levels are diminished following systemic or topical antibiotic treatment for bacterial infections, risk of infection by pathogenic microbes increases dramatically. Such conditions lead to the development of an imbalanced vaginal microbiome, known as bacterial vaginosis (BV). Studies on inulin have suggested that it can act as a “prebiotic” that promotes LC growth. However, inulin has not been tested at different concentrations or in synergistic combinations to further enhance LC growth. We monitored LC growth in liquid cultures over 0-24 hours in the presence of inulin (2-10 mg/mL). Biofilm assays using crystal violet were conducted to test inulin’s effectiveness on biofilm formation. We also tested inulin in combination with other enhancer candidates for potential synergistic effects. Our findings indicate that Inulin was most effective over a range of 2 mg/mL - 5 mg/mL. Additionally, inulin combined D-Lactic acid (6 mg/mL) and glycogen (3 mg/mL) produced an even greater enhancement of LC growth and biofilm formation. These results suggest that Inulin, especially in synergistic use, could potentially play a role in LC regrowth to manage BV.

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# Abstract: Science and Engineering Fair of Houston

**3094**

## Profiling Gene-Pair Reversals: A Novel, Epigenetically-Validated In-Silico Panel for Robust Detection of Colorectal Adenoma

Maxwell Tang

Katy ISD/Jordan - HS

Category:

Biochemistry and  
Microbiology

Colorectal cancer is the second-leading cause of cancer-related mortalities in the U.S. Yet, identifying robust and consistent molecular signatures for detecting colorectal cancer in its earliest stages remains challenging because biological differences between patients and variations in lab techniques across different datasets create inconsistent patterns of gene regulation. To address this, we developed an interpretable in-silico gene-pair approach using the k-Top Scoring Pairs (k-TSP) algorithm to classify adenoma versus normal colon tissue by identifying reversals in relative gene ranks instead of absolute expression levels. A k-TSP model trained on a balanced cohort (n=32 normal; n=32 adenoma) identified 25 candidate gene-pair rules. From these, a three-gene-pair panel (MMP7/SLC4A4, TGIF1/FGL2, QPCT/PCK1) was selected for consistent performance across two independent validation cohorts (n=67, n=23). In validation, the full k-TSP ensemble achieved 95.5–95.7% accuracy with AUC 0.981–1.000. The selected panel pairs also showed strong discriminatory performance, with AUCs across validation cohorts of 0.953–0.933 (MMP7/SLC4A4), 0.845–0.967 (TGIF1/FGL2), and 0.700–0.828 (QPCT/PCK1). In addition, we integrated an independent promoter DNA methylation cohort (n=105 normal; n=42 adenoma) and found that all six panel genes exhibit significant promoter methylation shifts in adenoma (change in beta ranges from  $-0.007$  to  $-0.127$ ,  $p < 8.6 \times 10^{-4}$ ), which are characteristic of early signs of cancer. Specifically, hypomethylation of MMP7 promotes over-expression and excessive extracellular matrix degradation, while hypermethylation of SLC4A4 and PCK1 suggests a loss of metabolic homeostasis and ion transport characteristic of early neoplastic transformation and formation of adenomas.

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# Abstract: Science and Engineering Fair of Houston

**3095**

## Protein-Ligand Docking In Dilated Cardiomyopathy

Ashwin Jacob

Clear Creek ISD /Clear Creek High School

Category:

Biochemistry and  
Microbiology

Dilated cardiomyopathy is a progressive disorder which is characterized by ventricular dilation and impaired systolic function, which can ultimately lead to heart failure. Growing research has connected this disorder to chronic inflammation, an immune dysregulation that increases damage to cardiomyocytes. Chemokine receptors have recently gained scientific interest for their role in infiltrating leukocytes, particularly in cardiac disorders like dilated cardiomyopathy. Recently, a new drug molecule, AZD0233, was developed to bind to the CX3CR1 receptor. Small changes to the molecules can have major implications for binding to the desired receptors. Exploring these changes can provide insight into the molecules' fundamental principles in binding. In this experiment, we aimed to test these impacts between the binding of the AZD0233 ligand and CX3CR1 chain using computational methods. The protein structure was obtained from the Protein Data Bank. The ligands were modified using ChemSketch software, which enabled us to directly change the functional groups on a 2D level and then to an energy-optimized 3D structure for the AutoDock Vina software. We found that the unmodified ligand performed the best with the lowest binding energy score to the CX3 chemokine receptor 1 compared to the modified ligands.

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# Abstract: Science and Engineering Fair of Houston

**3096**

## Designing a Signal-Decoy Antibiotic: Computational Design and Prioritization of Autoinducer Analogs that Competitively Bind Quorum-Sensing Receptors

Neel Kura

Conroe ISD /AST: Academy of Science and Technology

Category:

Biochemistry and  
Microbiology

Antibiotic resistance represents a critical global health crisis, with *Pseudomonas aeruginosa* identified as a WHO priority pathogen responsible for severe lung, wound, and hospital-acquired infections. Traditional antibiotics create selective pressure for resistance by killing bacteria. Antivirulence therapy offers an alternative approach: blocking bacterial communication (quorum sensing) without killing bacteria. However, a key question remains unanswered—will quorum sensing inhibitors remain effective if bacteria evolve mutations in their receptor binding sites? This study used computational molecular docking to identify LasR antagonists that maintain strong binding affinity across receptor mutations. Using AutoDock Vina, 89 compounds (1 native agonist, 4 known antagonists, and 84 novel computationally-generated analogs) were docked against wild-type LasR and 11 mutant variants. Mutations were selected at five evolutionarily conserved binding site residues (TYR56, TRP60, ARG61, ASP73, SER129) based on ConSurf conservation analysis and literature-reported functional significance. Results demonstrated that novel computationally-designed compounds significantly outperformed known antagonists, with the top performer (ligand\_51) achieving -11.08 kcal/mol binding affinity, stronger than the native agonist OdDHL. Critically, mutations had minimal impact on top compound binding (mean effect <0.5 kcal/mol), indicating strong mutation resistance. All top 10 compounds were novel designs rather than previously identified antagonists. This work represents a computational study of LasR antagonist binding to mutant receptors, providing predictions unattainable through experimental methods due to LasR instability with antagonists. These findings identify promising mutation-resistant drug candidates for antivirulence therapy development.

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- yes       no



# Abstract: Science and Engineering Fair of Houston

**3097**

## The Affects of Decreasing Sample Temperatures on Acridine orange Dimerisation

Isabelle Bostic

Private/Post Oak School

Category:

Biochemistry and  
Microbiology

Acridine Orange (AO) has highly ambiguous temperature guidelines, which can create major sample issues and significant waste over time in laboratory and medical settings due to the high temperature sensitivity of AO. Attempting to clarify what midline temperatures allow AO to dimerise enough for viable staining, we used UV-Vis spectrophotometry to determine the % change in the monomer and dimer ratios at 6 different temperatures that ranged between 28.3 °C and 13.8 °C inside of an HCl buffer as our "sample". I will be using the Beer-Lambert law equation to calculate the monomer-dimer ratio. I hypothesise that, as the temperature of the AO drops, so will the degree of AO dimerisation.

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# Abstract: Science and Engineering Fair of Houston

**3098**

## Combating Escherichia coli in Swimming Pool Waters: Identifying the Best Eco-Friendly Disinfection Approach

Laura Cai

Conroe ISD /AST: Academy of Science and Technology

Category:

Biochemistry and  
Microbiology

Water contamination remains a significant global health issue, contributing to the spread of waterborne diseases such as cholera and salmonella. Even treated recreational waters, including swimming pools, can harbor pathogenic bacteria such as Escherichia coli. This experiment investigated the effectiveness and environmental implications of several water disinfection methods—chlorine, sodium hypochlorite (bleach), hydrogen peroxide, and solar water disinfection (SODIS)—using E. coli as an indicator organism. Artificial wastewater contaminated with E. coli K-12 was treated with each disinfection method and then cultured on agar plates. Bacterial growth was measured by colony counts over a 72-hour incubation period. Results showed that hydrogen peroxide was the most effective disinfectant, consistently producing the lowest number of bacterial colonies. Chlorine was the second most effective, yielding low and stable colony counts, while sodium hypochlorite showed moderate effectiveness with higher variability. The SODIS method was the least effective but still reduced bacterial growth compared to untreated controls. These findings suggest that hydrogen peroxide may be a viable and more environmentally friendly alternative to traditional chlorine-based disinfection for pool water purification. This study highlights the importance of balancing microbial control with environmental sustainability in water treatment practices.

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