# CALIFORNIA STATE SCIENCE FAIR
# 2016 PROJECT SUMMARY

**Name(s)**

Ava Badger; Annika Bauerle

**Project Number**

**S1501**

**Project Title**

## E. coli Contamination in Shingle Mill Creek

**Abstract**

**Objectives/Goals**

Shingle Mill Creek is a non-point source of fecal coliform pollution into the San Lorenzo River. Last year, we determined that the coliform originates from an upstream location, where the density of houses is highest. This year, we investigated the source of fecal contamination in Shingle Mill Creek. We hypothesize that the coliform is most likely coming from faulty septic systems, as coliform bacteria can easily leach through the relatively sandy soil present along Shingle Mill Creek. We collect water samples bimonthly from 5 sites along the creek. Lab tests include membrane filtration and filter incubation on medium specific for E. coli. To further pinpoint the contamination source, we monitored creek nitrate levels, which can indicate malfunctioning septic systems. We are collecting rainfall data; high rainfall events should correlate with septic system failure. This year, we continue to find increased E. coli contamination upstream, along with increased nitrate levels. As El Nino begins, we hypothesize that fecal coliform concentrations and nitrate levels will increase.

**Methods/Materials**

Whirlpak bags, receiver flasks, pipettes, 0.45 µm membrane filters, funnels, M Coli blue media, absorbent pads, petri dishes, autoclave, Vernier nitrate probe and standards, LabPro, Abraxis Caffeine Analysis Test Kit. Collect water sample with Whirlpak bag; filter water sample (5 mL) from each location; test nitrate concentration with LabPro, nitrate probe, standards, and water samples; Caffeine analysis run at Santa Cruz County Wastewater Treatment Plant.

**Results**

Using StatPlus, we determined an R squared value of 0.1561, showing no significant relationship between E. coli and precipitation. Caffeine testing revealed that the water in Shingle Mill Creek on March 3rd, 2016 contained less than 0.175 ppb caffeine, which is not significant.

**Conclusions/Discussion**

We are unable to make a definite conclusion concerning the effect of precipitation on E. coli levels, although data suggest that higher precipitation in 48 hours before sampling may cause higher concentrations of E. coli. Our caffeine analysis data suggest that the source of contamination is not human. Even so, we did not determine coliform contamination in this same sample, therefore we are unsure if this water sample was simply low in coliform contamination. We experienced little rainfall before this sampling, which could have affected coliform levels.

**Summary Statement**

Precipitation causes an initial increase in E. coli contamination, followed by a decrease likely because of increased water flow in the creek, effectively lowering the concentration.

**Help Received**

We received guidance from Steve Peters, from the Santa Cruz County Water District, and Sam Blakesley, from the Surfrider Foundation. We received further help from Dave Bernick, a professor at UCSC, and Jennie Munster, a lab technician at the SC County Wastewater Treatment Plant.

# CALIFORNIA STATE SCIENCE FAIR
# 2016 PROJECT SUMMARY

**Name(s)**

**Sourish Bairaboina; Akshaj Bansal**

**Project Number**

**S1502**

**Project Title**

## Testing the Veracity of Cope's Rule on Microorganisms

**Abstract**

**Objectives/Goals**

Cope#s Rule postulates that descending lineages of a certain species tend towards an increased body size. It has been hypothesized that larger sizes allow for greater genetic diversity, allowing larger individual of the species to adapt to the changing environment. The presented results are the product of exposing different groups of bacteria to a constant environment with one varied, hazardous, condition. The presented research originally attempted to find some parallels between microbial and macro-ecology.

**Methods/Materials**

Diluted Ultraviolet C radiation and a bleach-water solution were incorporated within the environment of 3 bacterial species: bacillus Cereus, bacillus Megaterium, and bacillus Thuringiensis.

**Results**

By finding the ratio of bacterial growth in the hazardous environment to the growth at optimal conditions, we tested the general ability each species possessed in adapting to its environment. Contrary to the belief that the largest species, bacillus Megaterium, would show the largest ratio of growth , in UV C light trials, the species Bacillus Cereus performed better. Under the UVC light, the bacillus Megaterium, Cereus, and Thuringiensis had a ratio of 0.65, 0.86, and 0.57, and under bleach, the ratios were 0.78, 0.64, and 0.31, respectively. Thus, the obtained results lead to mixed results, and debatable interpretations.

**Conclusions/Discussion**

With these uncertain results, definite benefits are not immediately visible. However, this uncertainty proves that size in microorganisms does not play as prominent of a role in evolution as it does in organisms of the kingdom animalia. This may prompt more research to find a link between the size and adaptability of microorganisms.

**Summary Statement**

As we presented environmental hazards to bacteria, the largest bacteria flourished under bleach while the smallest bacteria excelled under radiation.

**Help Received**

My biology teacher, Ani Hanoian, offered materials and understanding about correct procedures for the experiment.

# CALIFORNIA STATE SCIENCE FAIR
# 2016 PROJECT SUMMARY

**Name(s)**
Stephany R. Brundage

**Project Number**
**S1503**

**Project Title**
## The Death of Diatoms

**Abstract**

**Objectives/Goals**
Looking at which genus of diatom survives and reproduces the most successfully to the rise in salinity of the sample.

**Methods/Materials**
Pond water samples rich in Diatoms, microscope with camera and computer hook-up, materials to make slides, saltwater solution, ATC saltwater refractometer, 1 mL/cc syringes. Add a measured amount of salt-water solution daily. Sample and count diatoms in each genus every three days for two weeks with one set of samples. Leave all samples with no disturbance for 3 weeks. Take final population counts.

**Results**
Diatom AO (unidentified) was the most successfull in adapting and surviving the rise of salinity in the sample. This diatom had no population in control samples, very low population in salinity level one, the highest population in level two salinity, and level three salinity had the second highest populations of this diatom.

**Conclusions/Discussion**
It is possible for diatoms commonly found in freshwater to adapt to the rise of salinity in the sample. The diatom that adapted the most successfully actually had the highest population in salinity level two (the second highest level). This is important to know because diatoms are a major part of the trophic level in aquatic ecosystems and with the California drought, bodies of water are drying up and the parts per million of salt is rising, which may cause diatoms to reduce in population.

**Summary Statement**
I looked at which species of diatom could adapt and reproduce the most successfully with the rise of salinity in its habitat and I found that there is a diatom that thrives in higher salinity.

**Help Received**
My Biology teacher helped me narrow down my topic and she provided me with some resources for identifying diatoms and other pond water microorganisms.

# CALIFORNIA STATE SCIENCE FAIR
# 2016 PROJECT SUMMARY

**Name(s)**

Maggie S. Chen

**Project Number**

**S1504**

**Project Title**

## Combating Antibiotic Resistant Bacteria Using Tissue Adhesive Hydrogel with Cell-Membrane Coated Nanotherapeutics

**Abstract**

**Objectives/Goals**

As strains of bacteria have evolved to acquire resistance against antibiotics, they have also developed mechanisms to evade the immune system. High dosages of antibiotics have the ability to eliminate these mutated bacteria, but are highly toxic to the individual due to the sheer volume needed to counteract the effects of diffusion and circulation. I aimed to synthesize a thermosensitive hydrogel containing cell membrane coated, drug loaded nanoparticles to provide localized and controlled delivery of drugs, targeting both the bacteria themselves and the external toxins secreted by them. This platform can deliver high concentrations of antibiotics directly to the infection source. Thus, it has the ability to eradicate antibiotic resistant bacteria, otherwise known as superbugs, without posing a threat to the patient.

**Methods/Materials**

First, I developed the formulation and methodology for synthesis of the thermosensitive, tissue-adhesive hydrogel and cell-membrane (from red blood cell) coated nanoparticles using double emulsion and nanoprecipitation methods. I then combined these two elements into a single platform, and tested the platform's ability in eliminating the growth of E. Coli and MRSA bacteria.

**Results**

Through extensive testing and positive results, I found that my drug-delivery platform was effective in delivering the drug and eliminating the growth of various strains of antibiotic bacteria; additionally, it was shown to absorb the secretory toxins from these bacteria to alleviate the effect of the pathogens on the immune system.

**Conclusions/Discussion**

My hydrogel-nanoparticle composite displays drug retention and toxin absorption abilities, as well as localized and controlled drug release properties. Moreover, my platform was able to use minimal antibiotic volume for maximum eradication efficiency. Therefore, my drug-delivery platform can be used as an injectable, effective method for treating strains of antibiotic resistant bacteria.

**Summary Statement**

I engineered a drug delivery platform with thermosensitive, tissue-adhesive hydrogel and cell-membrane coated nanotherapeutics to localize and control drug delivery for eradication of antibiotic resistant bacteria.

**Help Received**

Used the lab equipment of Dr. Liangfang Zhang at the University of California, San Diego

# CALIFORNIA STATE SCIENCE FAIR
# 2016 PROJECT SUMMARY

**Name(s)**

**Pelin Ensari**

**Project Number**

**S1505**

**Project Title**

## The Discovery and Test of a New Biologically Produced Acne Cream: Lacnend

**Abstract**

**Objectives/Goals**

The objective of this project is to ferment lactic acid, purify it, and create an effective acne cream.

**Methods/Materials**

The first study was to ferment the lactic acid using L. rhamnosus bacteria over the course of 7-10 days in MRS Broth. Then, the second study, was to purify the lactate using a liquid-liquid extraction with butanol as the single solvent. After purifying, the lactic acid was mixed with coconut oil to produce a 10% cream. This cream was tested on Tryptic Soy Broth agar plates with lawns of E. coli.

**Results**

The fermentation results showed a moderate fluctuation in the amount of lactic acid produced. The yield of lactic acid from glucose for each culture, respectively, was 71.78%, 68.78%, 65.08%, 67.34%, 64.11%, 75.76%, 77.18%. This fluctuation was not significant according to the Kolmogorov-Smirnov test ($p>0.05$). The three purifications# overall yields were, respectively: 81.5%, 61.8%, 47.6%. The results for testing the cream underwent a statistical analysis. There were 30 Lacnend, 48 control and 18 coconut samples. Bacterial growth was coded as -1 (no growth) to 1 (growth). Therefore, scores closer to 1 show that there is stronger growth. A one-way ANOVA (levels: control, coconut, Lacnend) indicated that the growth in Lacnend condition (mean= -0.4) was significantly lower than the growth in coconut (mean= 0.67) and control (mean= 1) conditions, $F(2, 95) = 48.61$, $p = 0.00$. The Lacnend condition was different than the other two conditions ($p = 0.00$), but the control and coconut conditions did not differ significantly ($p>0.1$).

**Conclusions/Discussion**

The results showed that the cream worked in inhibiting the growth of E. coli. Lacnend provides hydration to the skin because of the lactic acid and the coconut oil, and it has antimicrobial properties from the lactic acid. It is important to note that this cream is the first acne cream to have an ingredient which is biologically produced through bacteria. Also, it is the first acne cream to utilize only lactic acid and coconut oil in a cream which is effective against bacteria causing acne.

**Summary Statement**

The biological production of lactic acid through fermentation, purification, and creation of a cream using coconut oil proved to make an effective acne cream that is the first of its time.

**Help Received**

My teacher Ms. Bechtel, my advisor Semsi Ensari, Genentech, & SMCHS

# CALIFORNIA STATE SCIENCE FAIR
# 2016 PROJECT SUMMARY

**Name(s)**

**Michelle Essien; Everett Kim; Dianna Kwong**

**Project Number**

**S1506**

**Project Title**

## Comparing the Efficiency of Viral Phages to Those of Antibiotic and Antibacterial Compounds in Combating E. coli B

**Abstract**

**Objectives/Goals**

This study examined the effectiveness of Micro-phages versus antimicrobial disinfectants and antibiotics in combating E. Coli B. It was predicted that the antimicrobial & antibiotic compounds would be more immediately effective than the Viral phages in eliminating the growth of the E. Coli B. However, the phages are predicated to be ultimately more efficient because the phages should theoretically increase in population exponentially.

**Methods/Materials**

The TSA media was poured over 36 plates and the TSB distributed using auto pipettes. Then the growth media should be autoclaved. The given culture of Escherichia Coli B, was transferred using an inoculating loop from the original slant culture to the TSB, then cultured for a period of 36 hours. Individual disposable pipettes were used to distribute 2ml to the plates. The plates were then incubated for 36 hours to ensure a full carpet of bacteria. The bacterial combatants were prepared through sequential dilutions 30 minutes before applying them to the cultured plates. The same process would be repeated for the t4r Phage, the t4 phage, and the Neomycin based antibiotic. Using new pipettes, 2 ml of each dilution was spread evenly over the plates at 3pm on Friday. A control plate was taken for each sample as well.

**Results**

It was found that the phages were about three times more efficient than the other compounds over a 36 hour interval with an average efficiency of phage remaining consistently at or above three times to those of the antibiotic/antibacterial compound remaining consistently at or above three times at about (6,000 mm^2).

**Conclusions/Discussion**

This study#s results provide a pivotal comparison and understanding of the microbiological application of phages in potentially replacing disinfectants and antibiotics in domestic, medicinal, agricultural and other contexts where sterilization or combating pathogenic growth is necessary. These results are reflective of the actual uses of disinfectants in average day-to-day applications -the antimicrobial substances are diluted and dissociated through a liquid media versus a concentrated pad. The virus is durable in versatile environments versus the antimicrobials which expire after reaction. This and following research will pave the way for the long-term, cost-efficient, internationally and socioeconomically accessible solution.

**Summary Statement**

This study examined the effectiveness of Micro-phages (T4 & T4r) versus antimicrobial disinfectants composed of Triclosan & Triclocarban and antibiotics composed primarily of Neomycin Sulfinamide in combating Escherichia Coli strain B.

**Help Received**

Used Laboratory Equipment at Adamson Analytical Lab., inc. under Biotechnician Henry Huang.

# CALIFORNIA STATE SCIENCE FAIR
# 2016 PROJECT SUMMARY

**Name(s)**

Elan E. Filler

**Project Number**

**S1507**

**Project Title**

## A Novel Treatment for Candida glabrata Infection

**Abstract**

**Objectives/Goals**

Candida glabrata is a fungus that causes life threatening infection in humans. Recently, some strains have become resistant to current antifungal drugs such as caspofungin, and new drugs are urgently needed. Last year, I discovered that the transcriptional regulator Ada2 is required for C. glabrata to resist antimicrobial peptides and caspofungin, and is necessary for virulence in Galleria mellonella (wax moth) larvae. My hypothesis is that a compound that inhibits Ada2 can potentially be used to treat C. glabrata infection. My objective was to discover a new drug to treat C. glabrata infection.

**Methods/Materials**

Computer-assisted modelling, docking, and screening were used to identify potential Ada2 inhibitors. Ten of these compounds were selected based on structural diversity and availability and were purchased from a commercial source. To test for toxicity, each compound was injected into G. mellonella, and survival was monitored over a seven day period. Each non-toxic compound was tested for its capacity to protect G. mellonella from lethal C. glabrata infection using survival as the endpoint.

**Results**

Computer modelling generated a list of 400 potential Ada2 inhibitors. Of the 10 compounds that were selected and tested for toxicity in G. mellonella, only three were found to be non-toxic. Of these three, the compound 6-methyl-2-oxo-N-(2-pyridylmethyl)-1H-pyridine-3-carboxamide significantly improved survival of infected G. mellonella in two separate experiments ($p=0.011$ as compared to control by the log-rank test).

**Conclusions/Discussion**

I discovered that the compound, 6-methyl-2-oxo-N-(2-pyridylmethyl)-1H-pyridine-3-carboxamide, is a promising antifungal drug because it is nontoxic and prolongs survival in the G. mellonella model of disseminated C. glabrata infection.

**Summary Statement**

I discovered a new compound to treat serious infections caused by the fungus Candida glabrata.

**Help Received**

Dr. John E. Edwards, Jr. at Los Biomedical Research Institute was my mentor and provided me with guidance and laboratory space. However, I performed all the research independently.

# CALIFORNIA STATE SCIENCE FAIR
# 2016 PROJECT SUMMARY

**Name(s)**
Shayle Gupta

**Project Number**
**S1508**

**Project Title**
## In Search of the Ideal Protection for Humans from Physiologic Burns: Analysis of Ultraviolet Radiation Protective Agents

**Abstract**

**Objectives/Goals**
Skin cancer rates are continuing to rise in America and are primarily due to UV exposure. The purpose of this experiment is to determine the most effective skin protectant product for blocking ultraviolet (UV) radiation from the sun. Common bacteria from the mouth serve as a proxy for human skin as they have been shown to be damaged by UV radiation like human skin. Many commercial sunscreens, sunblocks, clothing items, and makeup are widely believed to be protective against sun exposure. There have been no comparisons reported of the relative effectiveness of these products. The hypothesis of this experiment was that different sun protectants would protect bacteria from UV radiation to different extents and that this would answer the research question identifying the most effective skin protectant.

**Methods/Materials**
Petri dishes with agar were inoculated with sun sensitive bacteria and allowed to grow for one week in the dark. A colony count was performed and one of the UV protectants was applied. The protected bacteria were then exposed to UV radiation and colony counts of the bacteria were made at three and seven days following UV exposure.

**Results**
This experiment found that sunblock containing zinc oxide performed the best with an increase in bacterial growth of 90% over seven days. The worst performing product was makeup with a 70% decrease in bacterial counts.

**Conclusions/Discussion**
Sun block with zinc oxide provided the greatest protection for the bacteria, though dry fabric also proved to be effective protection. Zinc Oxide and other agents described as sunblocks work by reflecting light rather than absorbing and altering it as sunscreens do. This project will benefit many people. Skin cancer continues to increase and is the most common cancer. This project has given better insight into which products will work the best for sun protection and is important information for everyone planning any sun exposure and for those people who provide recommendations for sun protection such as pediatricians and dermatologists. Extending this experiment to cultured human skin will confirm these findings and potentially reduce skin cancer rates.

**Summary Statement**
This experiment demonstrated that methods of protection from UV radiation differed in their ability to protect bacteria exposed to UV rays from the sun, and that sun blocks were significantly superior to other products.

**Help Received**
Minimal, as I designed, built, and performed the experiments myself, though my father confirmed the bacterial counts as a blinded observer to confirm my findings.

# CALIFORNIA STATE SCIENCE FAIR
# 2016 PROJECT SUMMARY

**Name(s)**

**Bowen Jiang**

**Project Number**

**S1509**

**Project Title**

## Towards a Novel Method for Combating Harmful Cyanobacteria in Freshwater

**Abstract**

**Objectives/Goals**

Across the globe, freshwater cyanobacterial harmful algal blooms (HABs) are increasing in frequency, and toxic blooms produced by several common species can pose significant human health risks as well as environmental problems. In contrast to saltwater HABs, however, far less research has been conducted on testing specific, environmentally-friendly treatments to selectively kill freshwater cyanobacteria. In this study, the efficacy of trans-resveratrol, a polyphenol produced in vascular plants, as a selective inhibitor of cyanobacterial photosynthesis, was investigated on Anabaena flos-aquae, a neurotoxin-producing cyanobacterium.

**Methods/Materials**

Cultures of A. flos-aquae (a non-toxic strain was employed) and Selenastrum, a non-toxic chlorophyte used as a toxicological model, were used in this study. In order to determine the effect of trans-resveratrol on population growth, both algae were grown in tubes with different amounts of trans-resveratrol added to each, and cell concentration was measured daily over the course of seven days. The rate of photosynthesis with and without trans-resveratrol treatment was determined by using a FireSting oxygen meter. Cells were collected and placed in a respiration vial connected to the meter, and photosynthesis and respiration were quantified by the rate of oxygen change in light and in darkness.

**Results**

Application of resveratrol to cultures of Selenastrum resulted only in marked inhibition of population growth and photosynthesis, suggesting that resveratrol may not be generally inhibitory to higher autotrophs. However, experiments to measure the impact of resveratrol on cultures of A. flos-aquae are still in progress, so it is not possible at this time to determine if resveratrol is specifically inhibitory to cyanobacteria.

**Conclusions/Discussion**

Application of resveratrol to cultures of Selenastrum resulted only in marked inhibition of population growth and photosynthesis, suggesting that resveratrol may not be generally inhibitory to higher autotrophs. However, experiments to measure the impact of resveratrol on cultures of A. flos-aquae are still in progress, so it is not possible at this time to determine if resveratrol is specifically inhibitory to cyanobacteria.

**Summary Statement**

In this study, a potential environmentally-friendly cure for toxic freshwater algal blooms was investigated.

**Help Received**

Professors Gordon V. Wolfe and Emily J. Fleming-Nuester of Department of Biology, California State University, Chico, helped me acquire and learn how to use the oxygen probe, and donated lab space for its use. In addition, Professor Wolfe helped provide chemicals and consumables for culturing A. flos-aquae.

# CALIFORNIA STATE SCIENCE FAIR
# 2016 PROJECT SUMMARY

**Name(s)**

Anthony K. Kang

**Project Number**

**S1510**

**Project Title**

## New Antibiotics: Conjugative Transfer of Cytotoxic Genes for Targeted Cell Elimination

**Abstract**

**Objectives/Goals**

With the increasing problem of antibiotic resistance in bacteria, a different approach is needed to combat bacterial infections beyond the continual overuse of antibiotics. This experiment demonstrates the viability of an alternative strategy: repurposing bacterial horizontal gene exchange, or conjugation, to transmit cytotoxic genes within a bacterial population for rapid and sustainable toxin delivery.

**Methods/Materials**

To emulate the population dynamics of the toxin delivery system, a MatLab-based predictive simulator was first written using conditional probabilities to determine necessary conditions for transfer of a toxin-encoding plasmid into recipient populations. Results were then lab verified using custom plasmid constructs of the ccdB genetic toxin regulated by the araBAD promoter; dubbed pT-BAD, these plasmids were synthesized from gene fragments isolated from different bacterial systems. Cytotoxic ccdB experimental and YFP control plasmids were transformed into donor K12 Escherichia coli and incubated with recipient K12 cells to conjugate the ccdB toxin or control YFP genes. Following arabinose induction, surviving populations were finally quantified using spectrophotometry.

**Results**

Eighty iterations of 5 minute conjugation intervals in the simulation yielded 240 minutes to be sufficient for complete transfer of the toxin-encoding plasmid into all potential recipient cells. In vitro data demonstrated that within 30 minutes of post-conjugation arabinose induction, populations receiving the ccdB toxin experienced significant population decline and remained at an unrecoverable flatline for the four hour duration, while control populations receiving nonlethal YFP continued to proliferate normally.

**Conclusions/Discussion**

Based on paired T-test analysis of the lab experimental results, the toxin experimental group showed statistically significant variances from the YFP control group, indicating that the toxin transmission system successfully targeted and inhibited cell growth in bacterial populations.

Here, reprogramming conjugation as an efficient drug delivery tool is shown to effectively transmit lethal cytotoxic genes within bacterial populations for inducible cell death. Future research could expand upon this genetic system to combat antibiotic resistant bacterial infections, as well as induce genetic cell death in other pathogens and illnesses using tissue-specific promoters and cytotoxic genes.

**Summary Statement**

My project addresses the problem of antibiotic resistance in bacterial infections using an alternative to antibiotics that employs bacterial gene transfer mechanisms for efficient drug delivery of lethal genes to kill bacterial populations.

**Help Received**

I carried out and designed my experiments independently, using lab facilities and equipment at the J. Craig Venter Institute, under the supervision of Dr. Philip Weyman.

# CALIFORNIA STATE SCIENCE FAIR
# 2016 PROJECT SUMMARY

**Name(s)**
Allison M. Kifer

**Project Number**
**S1511**

**Project Title**
## Using Yeast to Model Expired Sunscreen's Effectiveness

**Abstract**

**Objectives/Goals**
Using DNA repair deficient yeast to model expired sunscreen's effectiveness to absorb ultraviolet light. Hypothesize that expired sunscreen has a significant decrease in efficiency.

**Methods/Materials**
Used DNA repair deficient yeast (from Carolina Biological), plastic wrap, aluminum foil, two brands of sunscreen (with expired and non-expired samples), a UV lab bench, and an incubator. Grew UV sensitive yeast colonies on a YED medium. Replaced the petri lid with plastic wrap and covered one half with aluminum for each plate. For the control plate, added no sunscreen. For the expired plates, added expired sunscreen on the exposed side of the plastic wrap. For the non-expired plates, added new sunscreen of the same brand to the exposed side of the plastic wrap. Set all plates in a UV lab bench for 15 minutes. After exposure, replaced wrap with petri dish lids, placed in incubator, and analyzed observations.

**Results**
The experiment's results reflected that sunscreen does lose its effectiveness past expiration. After exposure, the areas of exposed yeast lawns were compared to the areas of the non-exposed yeast then averaged for the three trials. Average yeast growth after ultraviolet exposure for the expired sunscreens (EE1 and EE2) were significantly less (18.83% and 26.65% respectively) than the growth of the yeast colonies (96.98% and 87.30% respectively) with the non-expired sunscreens (EN1 and EN2). The results support the hypothesis that sunscreen's efficiency decreases over time.

**Conclusions/Discussion**
The expired sunscreen plates (EE1 and EE2) had significantly less average area growth of yeast than the non-expired sunscreens (EN1 and EN2) after three trials. This demonstrates that expired sunscreen loses significant effectiveness to absorb UV light.

**Summary Statement**
I used yeast colonies to model how sunscreen's efficiency to absorb ultraviolet light decreases past expiration, and found that sunscreen does lose its effectiveness.

**Help Received**
I learned how to plate cultures and use the UV bench safely from my biotechnology teacher. I used the specific yeast sample from the Carolina Biological website.

# CALIFORNIA STATE SCIENCE FAIR
# 2016 PROJECT SUMMARY

**Name(s)**
Janie Kim

**Project Number**
**S1512**

**Project Title**
## Development of an Effective, Low-Cost Hospital Room Disinfection System

**Abstract**

**Objectives/Goals**
The objective was to develop an effective, low-cost, energy-efficient hospital room disinfection system, to target outbreak-causing Gram-negative bacteria such as CRE. This project aimed to create a novel combination of non-caustic disinfectants that could be nebulized by a surface acoustic wave (SAW) to be effective against multidrug-resistant bacteria.

**Methods/Materials**
The novel combination of non-caustic disinfectants (C30/P5/E5000) was first developed in six stages of experimentation that involved identifying the most potent antiseptic compounds contained within contact lens solutions and then confirming its effectiveness against multidrug-resistant bacteria. I then SAW-nebulized C30/P5/E5000 (as well as 10% bleach and 70% ethanol, two common hospital disinfectants) within a testing chamber that contained cutouts of 5 common hospital surfaces (plastics, stainless steel, rubber, glass) that each harbored 500,000 CFUs of bacteria, and then enumerated surviving CFUs after 60 minutes of total exposure time.

**Results**
C30/P5/E5000 in liquid form was very effective against the carbapenem-resistant Gram-negative bacteria (including P. aeruginosa, K. pneumoniae, A. baumannii, and ESBL-1 E. coli), and was more effective than any of the other disinfectants tested. When SAW-nebulized, it was still extremely effective against the CRE pathogens, almost eradicating all CFUs in a 5.7 log reduction (p-values < .0001). The SAW device was also able to successfully nebulize the other disinfectants.

**Conclusions/Discussion**
The SAW device, which is inexpensive ($1) and requires little power (1 watt), was able to nebulize my novel disinfectant combination, C30/P5/E5000, to decontaminate five different types of surfaces harboring multidrug-resistant bacteria. This project showed the SAW device's potential for use in nebulizing disinfectants to kill pathogens on surfaces of important vehicles of disease transmission, such airplane cabins and hospital rooms. Use of this SAW-device+C30/P5/E5000 disinfection system would eliminate human error or inconsistencies from decontamination procedures, and help in preventing future CRE outbreaks.

**Summary Statement**
I developed a novel low-cost and energy-efficient hospital room decontamination system that is especially effective against Gram-negative bacteria.

**Help Received**
Monika Kumaraswamy and Leo Lin supervised me, helped me, and taught me lab procedures. The Nizet Lab and the Friend Lab at UCSD provided equipment and lab space.

# CALIFORNIA STATE SCIENCE FAIR
# 2016 PROJECT SUMMARY

**Name(s)**
Kamya Krishnan

**Project Number**
**S1513**

**Project Title**
## The Effect of Sucralose on the Growth of Gut Microbiota

**Abstract**

**Objectives/Goals**
The objectives and goals for my project were to clarify and prove the health implications of replacing sugar with artificial sugars, as they may be prone to causing less gut bacterial growth. Gut bacteria are a critical part of a human's health, and its decrease in number can lead to lack of nutrients being spread throughout the body, toxins circulating, and bad bacteria flourishing. Especially in America, health is something that our nation is striving to achieve, and artificial replacements, such as sucralose, is what stands as an obstacle to this goal by possibly destroying our bodies.

**Methods/Materials**
For my methods and materials, I analyzed the growth of E. coli with sucrose(table sugar), sucralose(artificial sugar), and with no added substrate as my control. I grew them each three times in two different amounts, 0.04g/66.6mL broth mimicking the effects of an intake of 50g of sugar which is the average recommended intake of any sugar, and 0.08g/66.6mL broth mimicking the effects of 100g of sugar which is the minimal everyday intake of sugar by an average American. I grew all my bacteria in LB broth solutions containing the specific solute amounts for 24 hours. I then serial diluted all my substances by 6 dilutions of 1 mL/9 mL broth and took 0.1 mL of my final dilutions and grew them on LB plates to count colony growth.

**Results**
The results I found were that the overall growth from all trials combined of the 0.04g trial was neutral from all three groups, but the 0.08g trial is what stimulated a decrease of 1.27B CFU's (13.66%) of the total growth of the sucralose group from the control. On the other hand, with the bacterial growth with sucrose, there was a growth from the total trials of 1.3B CFU's (10.95%) more than the control. The control remained neutral amongst both these variables.

**Conclusions/Discussion**
These results help me conclude that large amounts of sucralose causes a decrease in gut bacterial growth and large amounts of sucrose causes an increase in growth, which are both bad for our body. Overall, Sucralose is proven by my experiment to be liable of causing health implications due to bacterial decrease in the gut, which can cause malnourishment, obesity, and yeast infections. This path of research is a sign of proof that sucralose and sugar should not be overly consumed, as it can lead to health issues that can instead be easily be avoided.

**Summary Statement**
My project explores how different amounts of sucrose(sugar) and sucralose(artificial sugar) intake can cause variations in gut bacterial growth.

**Help Received**
My mentor, Mrs. Pamela Chow, helped guide me through my methods of LB agar pouring, serial dilution, and replating my diluted growth.

# CALIFORNIA STATE SCIENCE FAIR
# 2016 PROJECT SUMMARY

**Name(s)**

Ashima Kundu

**Project Number**

**S1514**

**Project Title**

## The Effect of Different Temperatures on the Chemotaxis of Physarum polycephalum toward Food in a Maze

**Abstract**

**Objectives/Goals**

The purpose of this experiment is to determine the effect of different temperatures on the chemotaxis of Physarum polycephalum towards food in a maze and its success rate in solving the maze.

**Methods/Materials**

Petri dishes, non-nutrient agar, sterilized oatmeal flakes, and Physarum polycephalum culture. Placed Physarum polycephalum in a petri dish with a plastic maze and sterilized oatmeal flakes at specific points inside at 0, 20, and 40 degrees Celsius after covering the petri dishes with aluminum foil for 60 hours and measured their growth and success rate in solving the maze.

**Results**

The most success in solving the maze was demonstrated by the Physarum polycephalum in the 20 degrees Celsius group. The 0 and 40 degrees Celsius groups showed no significant growth.

**Conclusions/Discussion**

The success rate in solving the maze at 20 degrees Celsius at the end of 60 hours was 83.33 percent. The success rate in solving the maze at 0 and 40 degrees Celsius was 0 percent.

From the results it was inferred that the ideal temperature range for the growth of the Physarum polycephalum somewhere close to 20 degrees Celsius, and that Physarum polycephalum cannot perform the vital function of finding food in temperature 20 degrees Celsius above and below its ideal temperature.

**Summary Statement**

I found the most ideal temperature for the success of Physarum polycephalum in solving a maze, guided by food sources.

**Help Received**

None. I performed and researched the experiment on my own.

# CALIFORNIA STATE SCIENCE FAIR
# 2016 PROJECT SUMMARY

**Name(s)**

Louis Lee; Vincent Lok

**Project Number**

**S1515**

**Project Title**

## Therapeutic Potential of Lactobacillus acidophilus to Mitigate Escherichia coli Infection in Artemia

**Abstract**

**Objectives/Goals**

Improve Artemia (brine shrimp) survival by coincubation with common strain of Lactobacillus to solve dilemma of bacterial disease and antibiotic resistance in aquaculture.

**Methods/Materials**

Culturing E. coli and Lactobacillus

A 1.8% Lactobacillus, 3% laboratory grade salt solution was prepared from Lactobacillus (Phillips Digestive Health Support; Bayer) and NaCl (Sodium chloride; Sigma). Competent E. coli were grown in 100 milliliters of LB broth (Difco) that was prepared accordingly,

Lysing Bacterial Samples

Samples were lysed overnight in a 4% solution of pectinase (Carolina) and 4% cellulase (Carolina) and then subjected to rapid freezing in a dry ice and 92% isopropanol bath and rapidly heated in a water bath at 40 ℃. Samples were then centrifuged at 10000 rpm for 10 minutes and the supernatant was separated from the lysate, which formed a clump of debris at the bottom. The supernatant and lysate were both resuspended in 3% NaCl solution.

Treating Brine Shrimp

An average of 20 brine shrimp were aliquoted into each well of a 6 well plates. The shrimp were treated with 0.5 mLs of a bacterial solution and the volume of each well was raised to 10 mLs using a 3% laboratory grade salt solution. Mortality was measured at 0, 12, and 24 hours post E. coli challenge.

**Results**

The E. coli challenge significantly decreased survival rates. The groups that were cotreated with live probiotic Lactobacilli displayed no increased survival rates. However, Artemia treated with the probiotic 6 hours prior to the E. coli challenge displayed increased a much higher survival rate than Artemia simultaneously treated with the E. coli challenge. Cells of L. acidophilus and E. coli were lysed and divided into supernatant and lysate components and used as treatments for the brine shrimp. Both lysed components of the probiotic and E. coli decreased the vitality of the brine shrimp.

**Conclusions/Discussion**

These results affirm that prior inoculation with the probiotic Lactobacillus acidophilus is necessary for Artemia survival and validates a novel, inexpensive method to solve the dilemma of bacterial disease and antibiotic resistance in aquaculture.

**Summary Statement**

We successfully conferred E. coli protection to brine shrimp using a common probiotic, Lactobacillus acidophilus.

**Help Received**

We designed and performed the experimentation without receiving any outside help.

# CALIFORNIA STATE SCIENCE FAIR
# 2016 PROJECT SUMMARY

**Name(s)**
Matthew G. Lee

**Project Number**
**S1516**

**Project Title**
## The Future of Food: The Effects of Red Abalone on Spirulina's Nutrient Concentration

**Abstract**

**Objectives/Goals**
The objective was to measure the nutrient concentration of Spirulina cultures fed with different food types (f/2 and red abalone feces). I chose to measure mono-unsaturated and saturated fatty acid concentration since in previously researched studies I found a correlation to chlorophyll a concentration, a value easily determined.

**Methods/Materials**
I had 1 control (f/2) and 2 treatment (red abalone feces) cultures over the course of my experiment. Cultures were grown in controlled environments and data collection of chlorophyll a concentration was accomplished through the use of a spectrophotometer and centrifugation.

**Results**
Although there was variation between initial and end behavior, there was a clear negative trend for the control and an end result of the treatment group having a chlorophyll a concentration about 75% of the control. Overall however, there was highly erratic behavior.

**Conclusions/Discussion**
I concluded that the abalone feces are not as effective of a food source as f/2 is. Due to the large variance of results, further protocols should be devised to prevent population crashing and restricted oxygen supplies, two possible discrepancies that affected my results.

**Summary Statement**
I showed that red abalone feces is not as effective of a food source as the commercially used nutrient when comparing monunsaturated and saturated fatty acid concentrations.

**Help Received**
I conducted all data collection and setup by myself. I performed the experiment at Cabrillo Marine Aquarium and received help from their Staff and their Young Scientist's program. I also received help from my science research teacher, Mrs. Munoz, who oversaw the entire process.

# CALIFORNIA STATE SCIENCE FAIR
# 2016 PROJECT SUMMARY

**Name(s)**

**Andrew Tong Li; Robert Yang; Matt Zhou**

**Project Number**

**S1517**

**Project Title**

## The Effects of Different Transition Metal Micronutrients on Carbon Fixation and Silica Intake of T. pseudonana Diatom

**Abstract**

**Objectives/Goals**

Our project aims to extend the Iron Hypothesis, a potential solution to climate change, originally proposed by oceanographer John Martin. We tested the effectiveness of using metals besides iron to bolster carbon fixation and silica intake of diatoms.

**Methods/Materials**

In order to do this experiment, we simulated an ocean environment by using ocean water from the Pacific Ocean and by controlling temperature, light, and air. We then cultured our strain of diatom, Thalassiosira Pseudonana, in our simulated marine environment. After the strains had been cultured properly, we then introduced transition metls iron, zinc and copper nitrates, each at different concentrations of 0.001, 0.01, and 0.1 g/L (these metals are cofactors in photosynthetic enzymes). As a control, we introduced sodium nitrate because sodium ions have no biological effect on the diatoms. EDTA was added as another control because it is a metal chelating agent that prevents the metals from affecting the diatoms. To measure cell growth, we performed cell counts at least twice a week. After the experiment, we filtered our culture to measure the dry weight of our diatoms. Using the remaining filtered medium, we placed it under spectrophotometry at 803 nm to measure the diatoms' silica intake.

**Results**

Our results showed that the diatoms in iron have the highest average weight compared to the diatoms in other solutions. However, diatoms in iron are weak absorbers of silica and their rapid growth from 300,000 to 650,000 cells over the course of 6 days foreshadows diatom blooms, which are detrimental to the environment. Zinc solution diatoms are the strongest absorbers of silica with absorbances from 0.001 to 0.002, and, with the exception of iron, they have the highest average weight at 0.01 g/L. Copper solution diatoms, on the other hand, can fixate the highest carbon, but the diatoms are unable to absorb much silica and begin to die after exposure.

**Conclusions/Discussion**

In conclusion, a mixture of the metals in fixed proportions will maximize the carbon fixation and silica intake. Iron should be added first to promote cell growth at 0.001-0.01 g/L along with the same concentration of zinc to maximize silica intake. After between six to nine days when the highest growth rate occurs, 0.1 g/L or more of copper should be added to maximize the carbon fixation right before it inhibits growth by killing the diatoms.

**Summary Statement**

We discovered zinc increased silica content of the diatoms, iron increased the carbon fixation of the diatoms, and copper inhibited detrimental diatom blooms.

**Help Received**

We designed the experiment completely by ourselves. We used lab equipment at our high school, Lynbrook High School under the supervision of Kathleen Loia and Lester Leung.

# CALIFORNIA STATE SCIENCE FAIR
# 2016 PROJECT SUMMARY

**Name(s)**

Liana N. Merk

**Project Number**

**S1518**

**Project Title**

## Effect of Novel Shock Inhibition on Efflux Pump Inhibitor NMP

**Abstract**

**Objectives/Goals**

My project aims to improve the efficiency of efflux pump inhibitor Naphthylmethyl Piperazine (NMP).

**Methods/Materials**

I performed my tests in New England Biotech's C2992 E. Coli strain. My idea of shock inhibition was dosing an efflux pump inducer (sodium dodecyl sulfate or ciprofloxacin), and then administering the putative inhibitor NMP. Using agar dilution, I compared the MIC's of the treatment groups. I then isolated RNA and performed rt-pcr in order to measure comparative gene expression.

**Results**

Shock inhibition decreased the MIC of ciprofloxacin by four fold, as opposed to two fold. Expression of resistance nodulating genes (AcrA/B, TolC, ompF, norE, marA) was significantly mitigated among the treatment groups.

**Conclusions/Discussion**

The performance of NMP was improved using Novel Shock Inhibition. Not only is a decrease in the amount of antibiotic needed achieved, but down regulation of key stress response genes was observed. Shock Inhibition offers a novel opportunity to increase efficiency of modern antibiotics, and my project also offers insight on the mechanistic action of NMP.

**Summary Statement**

I created and implemented a new way of fighting the antibiotic resistance crisis by trapping more antibiotic molecules within the bacterial cell.

**Help Received**

Dr. Jason Magida from Salk Institute trained me in mammalian RNA isolation and rt-pcr, but I am self-taught in how to translate these methods to bacterial models. I used equipment within Salk Institute Gene Expression Lab for my project. I also discussed my ideas with Mr. Ariel Haas, my biology teacher.

# CALIFORNIA STATE SCIENCE FAIR
# 2016 PROJECT SUMMARY

**Name(s)**

Anish R. Neervannan

**Project Number**

**S1519**

**Project Title**

## Modeling Deep Learning Neural Net Based Image Recognition to Classify Melanoma Better than a Trained Professional

**Abstract**

**Objectives/Goals**

The purpose of this experiment was to determine if the latest artificial intelligence (deep learning neural net) image recognition algorithms had reached a level of sophistication to create a melanoma classification model (deep learning classifier) that could distinguish melanoma from other forms of skin cancer (non-melanoma) more accurately than a trained professional#s classification mental model (human classifier).

**Methods/Materials**

Materials included a Windows laptop, 800 images of melanoma and non-melanoma scans collected from Lloyd-Derm, and Metamind's generic deep learning based image recognition algorithm. 640 images were used to train the computer algorithm and the remaining 160 images were used to determine the accuracy of the training. A subset of these 160 images was to a human classifier (an oncologist, a trained professional) for her to classify.

**Results**

After the deep learning classifier was trained to identify melanoma, its accuracy was compared to that of a human classifier with a controlled test sample. It was found that deep learning classifier had an accuracy of 85% and the human classifier had an accuracy of 68%.

**Conclusions/Discussion**

The deep learning classifier achieved a higher accuracy than the human classifier by a significant margin. Every year, skin cancer affects 5.4 million people in the US and costs $8.1 billion in treatment as the diagnosis of the disease costs up to $10000. The survival rate reduces from 94% to 15% when detected later. Detecting melanoma using the deep learning classifier is more accurate and quicker, thus positively impacting both the survival rate and the overall cost of diagnosis.

**Summary Statement**

Using a generic deep learning based image recognition algorithm, I created a classifier to distinguish melanoma from other forms of skin cancer with a higher accuracy than a trained oncologist.

**Help Received**

Dr. Swarajya Lakshmi Vemuri from Kaiser Permanente classified the medical images with her experience as an oncologist. Metamind's generic deep learning algorithm and images from Lloyd-Derm, DermNet NZ, and DermIS were used in this project.

# CALIFORNIA STATE SCIENCE FAIR
# 2016 PROJECT SUMMARY

**Name(s)**
Daniela A. Nieva

**Project Number**
**S1520**

**Project Title**
## Sanitization of Black Tea Using Ultraviolet Radiation

**Abstract**

**Objectives/Goals**
This purpose of this project is to sanitize tea of harmful microorganisms to make for safer consumption by immunocompromised persons.

**Methods/Materials**
Twenty 5 gram tea leaf samples were collected from tea bags and UV irradiated for varying amounts of time. Half of the samples were agitated as they were UV irradiated. The UV irradiated tea samples were plated on Sabouraud agar plates and placed in an incubator. Once a day, the plates were inspected to see if any mold spores appeared. Once I proved that UV light sanitizes tea of harmful microorganisms, I created a device that could sanitize larger quantities of tea. The experiment was repeated using the device, rather than UV treating each sample by hand. Each sample was plated, incubated, and inspected for spores.

**Results**
Black tea was irradiated for various time periods and plated on agar plates to see if UV light sanitizes black tea of harmful microorganisms. Half the tea was agitated as it was irradiated. The black tea that was agitated while being UV irradiated showed a significant decrease in harmful microorganisms. UV irradiation and agitation for over thirty-five minutes result in the sanitation of black tea of harmful microorganisms.

**Conclusions/Discussion**
My hypothesis that UV irradiation and agitation would sanitize black tea of harmful microorganisms was strongly supported by the results. I plan to extend my project and patent a device that will sanitize tea in individual portions for consumption by immunocompromised persons. Black tea was used in this experiment, but UV light also sanitizes other food products such as pepper. The findings of this experiment demonstrate a concrete way to improve the quality of life for immunocompromised persons by expanding their dietary options.

**Summary Statement**
My experiment shows that UV light can be used to sanitize food products of microorganisms harmful to immunocompromised persons.

**Help Received**
I designed and conducted the experiment myself. However, I was invited to conduct my experiments in the lab of Dr. Maria Elena DeBellard at CalState Northridge.

# CALIFORNIA STATE SCIENCE FAIR
# 2016 PROJECT SUMMARY

**Name(s)**

Christopher J. Paghasian

**Project Number**

**S1521**

**Project Title**

## Does Silica Depletion Affect the Growth and Domoic Acid Production of Pseudo-nitzschia australis?

**Abstract**

**Objectives/Goals**

Since 1991 the Monterey Bay has experienced eight algal blooms, one of the largest occurring during the summer of 2015. Many of the phytoplankton in these blooms produce domoic acid, which greatly deteriorates the neurological pathways of many marine predators and humans. During the latter half of an algal bloom, phytoplankton will have exhausted the majority of silica in its environment. This project investigates how silica depletion affects the growth and domoic acid production of Pseudo-nitzschia australis.

**Methods/Materials**

Nine flasks were prepared, with sets of three undergoing different conditions: control (autoclaved seawater), all nutrients (Guillard#s F/2), and silica depletion (Guillard#s F/2 without silica). Each sample underwent two tests: a cDA test, which calculated the amount of domoic acid in the sample#s total biomass, and a tDA test, which calculated the amount of domoic acid in one mL of the culture. An ELISA test allowed for the amount of domoic acid per cell to be calculated through a spectrophotometer.

**Results**

The results showed that in Pseudo-nitzschia australis, domoic acid production increases under silica depletion but cell growth significantly decreases.

**Conclusions/Discussion**

Even when silica has been exhausted from the environment, Pseudo-nitzschia australis can still pose a threat to marine predators and humans. Further research might investigate how many different environmental factors (copper exposure, the addition of phosphorus and nitrogen, temperature changes, or fluctuations of pH) affect the growth and domoic acid production of Pseudo-nitzschia australis.

**Summary Statement**

I investigated the effects of silica depletion on the domoic acid production and cell growth of Pseudo-nitzschia australis to simulate environmental conditions toward the end of an algal bloom.

**Help Received**

Moss Landing Marine Laboratories provided laboratory space and equipment. Mr. Jason Smith opened up his laboratory, and Ms. April Woods mentored me in the use of laboratory equipment and was a primary source for information on Pseudo-nitzschia.

# CALIFORNIA STATE SCIENCE FAIR
# 2016 PROJECT SUMMARY

**Name(s)**

Titus M. Patton

**Project Number**

**S1522**

**Project Title**

## Antimicrobial Properties of the Natural Flora Found in Stingray Mucus

**Abstract**

**Objectives/Goals**

Better show the effect mucus has on bacterial growth
Purify isolate cultures of bacteria found in mucus
Extract bacterial DNA and obtain genotypic sequencing

**Methods/Materials**

Mucus was collected from stingrays at the Fresno Chaffee zoo. The mucus was then centrifuged and resuspended in a tbs solution to help purify the sample. Then using various methods provided within microbiology studies and by mentors at the California State University, Fresno various tests were conducted. These include minimum inhibitory concentration testing, disc diffusion assays, and single colony isolation.

**Results**

Partial inhibition of B. subtilis growth was observed in disc diffusion array.
The MIC was successfully found and inhibition was shown in all 6 liquid cultures.
To measure physical indiscriminate growth optical density(OD) of cultures was taken. These densities show a definite increase in bacteria present over stock cultures especially as mucus concentration increased. The stock cultures of P. fluorescens and P. aeruginosa when subjected to various concentrations of mucus showed a definite stress through the secretion of a metabolite which appeared green. Pure cultures isolation was achieved. This is the next crucial step in continuing the research of the natural flora of the Cownose Ray.

**Conclusions/Discussion**

Partial inhibition of B. subtilis growth was observed in disc diffusion array. Other cultures showed minimal inhibition in response to stingray mucus in concentrations initially tested. It is possible that inhibition could be observed following treatment with a higher concentration of mucus. Initially, the minimum inhibitory concentration (MIC) assay showed the mucus to be effective against stock culture growth at higher concentrations. The OD is showing the death of the stock culture while the natural bacteria remain.
e stock cultures of P. fluorescens and P. aeruginosa when subjected to various concentrations of mucus showed a definite stress through the secretion of a metabolite which appeared green. A biofilm after a day also started to form suggesting the death of bacteria. Pure cultures isolation was achieved. This is the next crucial step in continuing the research of the natural flora of the Cownose Ray. Further methodology will be used for DNA extraction and analysis of these cultures.

**Summary Statement**

Identifying the source of the Cownose Ray's ability to fend off and prevent bacterial infection and disease.

**Help Received**

Used laboratory facilities and equipment at California State University Fresno under the direction of Dr. Brian Tsukimura, Ph.d  Laboratory procedures and methods were advised on by Andrew Strankman
Mucus Collection procedure was advised by Dr. Lewis Wright D.V.M at the Fresno Chaffee Zoo

# CALIFORNIA STATE SCIENCE FAIR
# 2016 PROJECT SUMMARY

**Name(s)**

**Brett J. Rabun**

**Project Number**

**S1523**

**Project Title**

## Transformation of Antibiotic Resistance in E. coli

**Abstract**

**Objectives/Goals**

Develop resistance to Gentamicin and Ciprofloxacin in one strain of E. coli, then transform the resistance to the wild type E. coli.

**Methods/Materials**

Tested the transference of antibiotic resistance through transformation of plasmids by first creating an antibiotic strain, calculating visual plate coverage, then killing it and transforming the plasmids into a wild type E. coli strain using a heat shock method, and once again calculating visual plate coverage.

**Results**

Transformation of the Ciprofloxacin resistant E. coli was successful but transformation of the Gentamicin resistant E. coli was not. Aminoglycocides, the drug class of Gent., is less likely to have a resistance built and less likely to transform because of the rapid loss of cell functions from the protein inhibiting properties of Gentamicin.

**Conclusions/Discussion**

The difference is Aminoglycocides, drug class of Gentamicin, attach to multiple places on the target cell kill the cell very fast while Fluoroquinolones, drug class of Ciprofloxacin, only stop one enzyme function and kill slowly. This means that transformation could occur quick enough to resist Ciprofloxacin but not Gentamicin.

**Summary Statement**

I created antibiotic resistant E. coli, killed the bacteria and transformed the genes leftover using a heat shock transformation into a new generation of E. coli to see if the wild type E. coli would exhibit the same resistance as before.

**Help Received**

After researching the project, I discussed which antibiotics I wanted to use with Dr. Fernandez who suggested a few others and helped procure them. I reviewed my procedure with Dr. Park and he suggested methods of transformation, I researched the methods suggested and choose Heat Shock.

# CALIFORNIA STATE SCIENCE FAIR
# 2016 PROJECT SUMMARY

**Name(s)**

**Meghana B. Reddy**

**Project Number**

**S1524**

**Project Title**

## Computer Aided Discovery of Inhibitors of the VP35 Protein of the Ebola Virus

**Abstract**

**Objectives/Goals**

VP35 is a polymerase cofactor and multifunctional protein that interferes with host-cell antiviral resistance mechanisms and it is essential for viral replication and immune-system evasion. Without functional VP35, the ebola virus cannot replicate, making the protein a good drug target. VP35 is also a transcription cofactor and contains an interferon inhibitory domain. With computer-aided drug discovery, will it be possible to identify molecule(s) that inhibit the protein, leading to a novel treatment for the virus?

**Methods/Materials**

Nine VP35 inhibitors, identified from the Protein Data Bank, were used as positive controls. The other (uncharacterized) molecules included in the virtual screen came from the National Cancer Institute (NCI). Different docking scoring functions were used with different protein models to identify combinations that were particularly good at separating the known compounds from the other molecules, as measured by the area under the ROC curve. The best combination involved docking the NCI compounds into the 4IJE crystal structure with AutoDock Vina and then rescoring the docked poses with a scoring function called rf2013_best_vina.

This same predictive combination was then used to pick potential VP35 inhibitors from among ~110,000 compounds that are commercially available through Chembridge. In this Chembridge screen, the area under the ROC curve was an impressive 0.97.

**Results**

By using the NCI compounds for #benchmarking# the proteins, the data yielded that through the cutoffs there were a possible of 5 proteins. The top performing protein with the scoring function rf2013_best_vina was used to on a larger Chembridge set in which the known ligands ranked among the top ~7% leaving possibilities for potential drug targets.

**Conclusions/Discussion**

There were 5 compounds that made the virtual screening cutoffs for RMSD, early performance, and ROC out of 26 receptors, 11 docking scoring functions, and 286 virtual screens, leading to a possibility of 5 compounds that have a potential to inhibit the VP35 protein of the ebolavirus.

**Summary Statement**

In an effort to further the development of novel drugs against this deadly pathogen, computer-aided drug discovery was used to identify several predicted low-micromolar inhibitors of the polymerase cofactor VP35 from a larger compound libr

**Help Received**

At the outset, I would like to thank Dr. Rommie Amaro for giving me the opportunity to work on my project at the Amaro Lab at the University of California, San Diego. Further, I am extremely grateful to the National Biomedical Computation Resource center for giving me the resources to advance my project

# CALIFORNIA STATE SCIENCE FAIR
# 2016 PROJECT SUMMARY

**Name(s)**

Abheer Singh

**Project Number**

**S1525**

**Project Title**

## Inhibition of Bacterial Mutagenesis through Polyubiquitination: A Solution to Antibiotic Drug Resistance

**Abstract**

**Objectives/Goals**

Bacterial cells can have DNA damage due to transcriptional error, or through the effect of an antibiotic. The SOS response is a bacterial cell program for coping with DNA damage, in which the cell cycle is arrested, and DNA repair is induced. The repairs have high probability in leading to mutagenesis in the bacteria, which can lead to antibiotic resistance. The RecA protein in bacteria is responsible for the activation of the SOS response; therefore, making it a target for inhibition. Developing a method to degrade RecA in bacteria, can inhibit SOS response related mutations, preventing antibiotic drug resistance.

**Methods/Materials**

The ubiquitination system was elected as a means of targeted degradation of the RecA protein in bacteria prone to mutations. Polyubiquitination of misfolded proteins leads to the breaking down of the protein with the aid of proteasomes. Using random forest-predictors, a statistically high likelihood of ubiquitination of the RecA protein in high risk bacterial infections, such as MRSA and TB, was determined. It was hypothesized that ubiquitin-tagging on RecA could be fostered by forcing the protein to misfold. Chaperones are proteins which interact with each other to prevent proteins from misfolding. CHIP (C terminus of HSC70-Interacting Protein) is a biomolecule that inhibits interactions between the chaperones of RecA. Adding CHIP, ubiquitin, and proteasomes into the bacterial system, theoretically leads to the degradation of the RecA protein. This was tested by conducting an assay for monitoring CHIP-mediated ubiquitination.

**Results**

Analysis was conducted on the assay using SDS-Page gel electrophoresis, and Western-blotting. The resulting data showed signs of polyubiquitination on the RecA protein, with chains of five or more ubiquitin, showing high drug potential.

**Conclusions/Discussion**

Adding an antibody drug conjugate, containing all the necessary components of a CHIP-mediated ubiquitination reaction, to common antibiotics can lead to the inhibition of bacterial mutagenesis, and higher antibiotic drug potency.

**Summary Statement**

My project tests the possibility of polyubiquitinating the RecA protein, as a method of inhibiting bacterial mutations, to fight antibiotic drug resistance.

**Help Received**

The experimentation involved in my project was conducted at Dx-Sys, a lab in Mountain View. I received assistance from the staff there in using the equipment, and analyzing my data.