CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)

Vinay Ayyappan

Project Number

S1501

Project Title

A Novel Method of Mitigating Bacterial Quorum Sensing via Inhibition of Autoinducer-2 by Polyvinyl Alcohol

Abstract

Objectives/Goals

A recent trend in microbiology appears to be a rising prevalence in bacterial infection that cannot simply be resolved through standard antibiotic treatment. Bacteria communicate using a signal-transduction mechanism known as quorum sensing. Bacteria release signal molecules called autoinducers. Autoinducers increase in concentration as bacterial population increases. When the concentration reaches a threshold level, genes alter in expression, enabling the bacteria to perform specific functions. One such autoinducer, autoinducer-2 (AI-2), contains boron. This experiment seeks to impair the function of AI-2 through the use of polyvinyl alcohol (PVA),which has high affinity for boron. PVA could be a means of inhibiting the activity of AI-2, which depends on boron in its molecule for its activities.

Methods/Materials

In this experiment, Vibrio and E. coli cultures were prepared. E. coli was cultured in LB-media containing PVA. After 24 hours, Vibrio cultures were transferred to Autoinducer Bioassay Media. The E. coli cultures were centrifuged, and the supernatant was transferred to Vibrio samples. After the vibrio samples were grown overnight, bioluminescence measurements were taken and analyzed both qualitatively and quantitatively using ImageJ software, measured in Corrected Total Cell Fluorescence. As a control, vibrio were assayed for bioluminescence after being inoculated with supernatant from E. coli samples not grown in media containing PVA. The experiment was conducted using three control samples, nine samples containing 0.5% PVA, nine samples containing 1% PVA, and nine samples containing 2% PVA.

Results

Of the thirty assayed samples, all of the controls visibly displayed bioluminescence whereas only five of the nine samples containing 0.5% PVA, four of the nine samples containing 1% PVA, and two of the nine samples containing 2% PVA displayed visible bioluminescence. The average Corrected Total Cell Fluorescence of the control was 209358.33 CTCF, compared to 205940.20 CTCF in samples containing 0.5% PVA, 190344.78 CTCF in samples containing 1% PVA and 130450.84 CTCF in samples containing 2% PVA.

Conclusions/Discussion

The results of my experiment proved my hypothesis correct-- PVA is effective in inhibiting the activity of AI-2. V. harveyi uses AI-2 both to regulate bioluminescence and virulence, meaning that these results demonstrate the effectiveness of boron sequestration in curtailing virulence.

Summary Statement

My project explores the signal transduction pathways that bacteria use to gage population density and seeks to disrupt those pathways by sequestering boron from signal molecules.

Help Received

Used equipment and facilities at Schmahl Science Workshop under supervision of Ms. Ibtisam Khalaf, Dr. Aru Hill; borrowed camera from Dr. Yusef Ismail; Parents provided immense love and support

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)
Vito A. Canuso, IV

Project Number
S1502

Project Title
Fertilizer's Effect on Scenedesmus Growth

Abstract

Objectives/Goals
The purpose of this experiment is to find out the effects that different amounts of the essential elements found in fertilizer have on the growth of algae. This ties into the use of aquaculture of algae to create biofuel and creation of dead zones by the eutrophication of oceanic environments.
If I vary the amounts of the nutrients in the fertilizer used to grow algae, then the algae will grow best in the fertilizer with the combination of the medial amount of nitrogen, phosphate, and iron. The fertilizer with plenty of nitrogen and iron lacks an abundant amount of phosphate. The fertilizer with plenty of phosphate has less nitrogen and completely lacks iron. Therefore, the fertilizer with a medial amount of all three nutrients will grow the best.

Methods/Materials
This experiment requires two fertilizers, beakers, Scenedesmus algae cultures, a microscope, and pipettes. First pour 100mL of water into 6 beakers and add 100mg of fertilizer. Vary the amounts of fertilizer such that one beaker has no fertilizer (control) and the rest have differing amounts of the two fertilizers such that the total fertilizer is still 100mL per beaker (100mg/0mg, 80/20, 50/50, 20/80, 0/100). Each day, prepare four slides for each beaker and count the number of cells per 4 square millimeter area using a 100X magnification microscope.

Results
The control grew 4.5 cells per 4 square millimeter area and tied with 100/0 fertilizer (nitrate, most phosphate, no iron). 0/100 grew 6.5 cells per 4mm area (nitrate, most iron, no phosphate). 20/80 and 80/20 fertilizers also happened to tie with a growth of 7.0 cells per 4mm area. 50/50 fertilizer (medial nitrate, phosphate, and iron) grew the best with a growth of 13.0 cells per 4mm area.

Conclusions/Discussion
My hypothesis was accepted because this experiment demonstrated that the algae with the medial amount of all three of the essential nutrients iron, nitrate, and phosphate had the greatest increase in cells per unit area. Some possible problems with the experiment could be there was too much amount of the essential nutrients for the algae. Also, tap water was used in this experiment and not distilled water, so there could be some dissolved minerals in the tap water that the algae could have reacted to. It could be possible that some of the algae cultures could have been duds or could have been damaged during shipping.

Summary Statement
This experiment tests the effects of the amount of the nutrients iron, nitrogen, and phosphate in fertilizer on Scenedesmus algae growth.

Help Received
Parents bought supplies, parents drove me to collect materials, and used a microscope from Villa Park High School lent to me by Mrs. Walburn.

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)
Sarah S. Chang

Project Number
S1503

Project Title
Mindless Mold: Physarum polycephalum Intelligence

Abstract

Objectives/Goals
Physarum polycephalum are a unique slime mold protist species that contain a primitive intelligence when it comes to navigation and response to stimuli. Since the species P. polycephalum has been known to navigate the most efficient route to its food source and also has been known to distinguish its most nutritional diet, will the Physarum still chose the most efficient food source even if it is not the most nutritional? Or will the P. polycephalum choose the most nutritious diet even if it must navigate through an inefficient pathway?

Methods/Materials
Physarum polycephalum was ordered from online Carolina Biological Supply company along with petri dishes, 2% (non-nutrient) agar, sterilized scalpels, and oat flakes for slime mold#s diet. Jellyroll sheet was sterilized and acted as giant petri dish for P. polycephalum. After pre-trials were conducted, P. polycephalum was placed on the jellyroll pan in agar maze created using plastic strips. Oat flakes were placed at farthest, most difficult part of maze while other, less nutritional diets place closer to starting point of P. polycephalum. Slime mold growth and behavior was then measured and recorded.

Results
Pre-trials demonstrated how long the slime mold can continue streaming and searching for its food source. At its fastest Physarum has been observed to grow at 1.35 mm per second so it was unsurprising that the Physarum traveled a total of 140.4 cm. The nutrient choice experiment was also recreated however the main experiment is still currently being conducted.

Conclusions/Discussion
P. polycephalum#s complex cytoplasmic steaming behaviors are considered a possible method to help plan future roadway or other transportation construction. An experiment that determines what choices the slime mold will make when confronted with more complex decisions will refine the knowledge about Physarum. Knowing more about P. polycephalum#s behavior, is necessary if slime mold is ever going to be a viable option for modeling transportation systems.

Summary Statement
Mindless Mold tested whether nutrient content versus efficiency was more important in Physarum polycephalum navigation.

Help Received
Permission from AP Biology teacher, Beth Dixon, to use equipment from school and parents helped order materials.

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)

Eric S. Chen

Project Number

S1505

Project Title

Towards a Combination Antiviral Therapy for Flu: An Interdisciplinary Drug Discovery Effort

Abstract

Objectives/Goals

A pandemic outbreak of a highly pathogenic influenza virus such as the avian H5N1 or H7N9 strain could potentially kill millions of people before new vaccines become available. Since current antiviral drugs are losing their effectiveness as resistant virus strains emerge, new anti-influenza drugs are urgently needed. My hypothesis is that blocking the influenza cap-snatching step is a good strategy for developing the next-generation anti-flu medicine.

Methods/Materials

I performed co-crystallography to identify more potent inhibitors of PA endonuclease. I used a docking-based virtual screen followed by biological validation to discovery cap-binding inhibitors of the PB2 subunit. Using a viral transcription assay, I found inhibitors of PA and PB2 had better effect when used together than either on alone.

Results

I was able to discover new drug leads for two different subunits of the influenza polymerase that show promise for development into new flu medicine. Structural information from co-crystallography and docking also will be vital for further drug design and optimization.

Conclusions/Discussion

Therefore, the newly discovered inhibitors of PA and PB2 can potentially be used in a combination therapy to reduce the chance of developing drug resistance.

Summary Statement

A multidisciplinary approach combining crystallography, computational chemistry, and biology was used to discover new drug leads for influenza targets that show potential for application in a combination therapy.

Help Received

Used the lab equipment of Dr. Feng, Dr. Amaro, and Dr. Wilson.

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)

Sara D'Souza

Project Number

S1506

Project Title

Analysis of Inter-Kingdom Microbial Interactions Captured by Imaging Mass Spectrometry

Abstract

Objectives/Goals

The purpose of this project is to identify and characterize communication signals in polymicrobial communities using mass spectrometry as a novel tool. Understanding the inter-kingdom communication will help us to study more complex communities such as those living in human bodies which affect our health. Studying how the microbial communities secrete and exchange molecules is invaluable in understanding diseases such as cystic fibrosis, cholera, Crohn#s Disease and can lead to the discovery of novel approaches for antibiotics.

Methods/Materials

Materials: MALDI Matrix,BHI Agar,Tryptone,Yeast,Dextrose,Milk Powder,Bacto-Agar,Xantham Gum,Cheese Curds,MALDI,LTQ-FT,Cheese,MALDI plate,JB182 Bacteria, RS17,RS12,162_3 Fungus
Microbial Growth: Plate Bacteria,Fungus,Bacteria/Fungus,and Bacteria & Fungus on cheese curd agar-allow growth
MALDI Imaging Mass Spectrometry(IMS):Place agar onto MALDI plate with Matrix,dehydrate,analyze MALDI signals
Molecular Networking and Dereplication:Sonicate agar,add various solvents,and collect supernatant.Infuse sample into LTQ-FT Mass Spectrometry.Use Global Natural Products Social Analysis (GNPS) to form Molecular Network and dereplicate by database.

Results

To study interkindgom polymicrobial microbial interactions, bacteria and fungus were grown on agar. Using MALDI Spectrometry, I was able to identify unique organic small molecules secreted by the microbes in proximity and in co-culture. The compounds followed interesting distributions indicating distinct functions and purposes between microbes. To further understand the molecular mechanisms of the interactions, I used molecular networking bioinformatics tools (GNPS) that would aid in finding the identity and structural analogues of the natural products. I then used dereplication tools to find the structures of those molecules compared to millions of known natural products from various databases.

Conclusions/Discussion

Mass Spectrometry is a new platform to understanding polymicrobial interactions. These microbes interact with one another by secreting small molecules. This process and workflow of MALDI Imaging Mass Spectrometry, molecular networking, and dereplication techniques is an effective and efficient system for analyzing the interactions in multispecies communities. In this study, I have found novel compounds that may help us to decode the secrets of microbial interactions.

Summary Statement

In this project, I identified and characterized unique metabolic signals that only occur in inter-kingdom polymicrobial interactions using novel mass spectrometry, molecular networking, and dereplication approaches.

Help Received

Research Work: Professor Pieter Dorrestein's laboratory at UCSD under the supervision of Dr. Laura Sanchez.

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)

Jasmeet S. Dhaliwal

Project Number

S1507

Project Title

Antibiotic Resistance Patterns of Staphylococci from the Human Skin

Abstract

Objectives/Goals

The objective of this project is to determine if staphylococci gathered from different regions of the human skin show patterns of resistance to different antibiotics. My hypothesis is that staphylococci isolated from the surface of the human skin will show resistance to some of the antibiotics yet display sensitivity to the others and that staphylococci from the fingers will show the highest resistance to antibiotics.

Methods/Materials

First collect samples from the arms, fingers, and nose using sterile swabs. Then rub these swabs on sterile Material Salt Agar (MSA) petri dishes; place the petri dishes in an incubator at 37 ºC for 48 hours. Take a colony from each Petri dish and isolate a pure culture by quadrant streaking on new sterile MSA Petri dishes. Incubate the petri dishes at 37ºC for 48 hours. After determining that the colony is a pure culture, stain the Staphylococcus and view under the microscope. Gram staining involves the use of crystal violet, gram's iodine, alcohol decolorizer, and safranin. Then inoculate NA and TSA Petri dishes densely with the pure Staphylococcus culture. Dispense the various antibiotic disks (penicillin, methicillin, oxacillin, kanamycin, and bacitracin) onto the Petri dish in a wide circle. Allow the bacteria to grow in the incubator for about 24 hours. Afterwards, using the Kirby-Bauer method, measure and record the zone of inhibition of each antibiotic using a millimeter ruler, and determine the effectiveness of each antibiotic against Staphylococcus.

Results

Data from the three different areas of the human skin indicates that the average zone of inhibition for penicillin, methicillin, oxacillin, and kanamycin was above the susceptible limit specified by the Kirby-Bauer method. Statistical analysis, however, reveals that the results of only three of these antibiotics (methicillin, oxacillin, and kanamycin) were statistically significant. More trials must be performed using penicillin in order to verify its effectiveness as an antibacterial agent. Because the zone of inhibition for bacitracin was consistently 0 mm, it is safe to say that the staphylococci were resistant to bacitracin.

Conclusions/Discussion

Staphylococcus was resistant to bacitracin and possibly penicillin, yet susceptible to oxacillin, methicillin, and kanamycin. Staphylococci from the nose were the most resistant to antibiotics, followed by the fingers, and finally the arms.

Summary Statement

My project is an investigation of the antibiotic resistance patterns of staphylococci from the human skin.

Help Received

I used lab equipment at CSUB, where I received help and guidance from Dr. Antje Lauer in regard to proper lab techniques. Also, my parents helped design the project board.

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)
Avika Dhillon; Matthew Gayed

Project Number
S1508

Project Title
Cell Phone Radiation and Its Effects on Bacteria

Abstract

Objectives/Goals
The project is intended to assess the effects of cell phone radiation on bacteria found in the ear, specifically Staphylococcus Epidermidis using Escherichia Coli DH5 alpha as a comparison to see if cell phone radiation would also affect a stable bacteria. In future testing, we would increase the dilution from a 1:10 to 1:50 dilution to prevent the colonies from sticking together providing a more accurate count of bacteria. We would also like to test possible ways of reducing the radiation that seems to be leaking from the cell phone.

Methods/Materials
We isolated the two groups of bacteria, the control and the test, from one another, using a lead shield, ensuring that our results are accurate. We then called the bacteria 22 times a day, for a minute and 30 seconds each, for four days. We kept the bacteria at 37 degrees celsius, using an incubator, to mimic the warm environment of the human body.
Staphylococcus epidermidis bacteria, Escherichia coli bacteria, ruler, pencil, petri dish, smartphone, gloves, ethyl alcohol, alcohol wipes, notebook, poster board, paper, pens, agar, inoculating loop, plastic tabs, water, measuring cup,syringe, measuring spoon, lighter, pipet, pipet caps, incubator, lead shield, and test tubes.

Results
Staphylococcus Epidermidis control: over 300 colonies counted
Staphylococcus Epidermidis test 1: over 500 visible individual colonies many more unverifiable due to massing
Staphylococcus Epidermidis test 2: over 600 colonies counted
Escherichia Coli (control and test): colonies to vast to count, but after observation, the test group seemed more dense

Conclusions/Discussion
From our research and personal first hand tests, we have concluded that when Staphylococcus Epidermidis bacteria is treated with cell phone radiation, growth is affected. Also, we have found that the Escherichia Coli had marginal difference between the test and control groups, with the test showing more dense colonies. The effect of the cell phone radiation was that the bacteria grew at a faster rate than that of the control group, specifically in the Staphylococcus Epidermidis bacterial group. From this we have determined that the excessive use of cell phone may cause a more rapid growth of Staphylococcus Epidermidis bacteria on your skin and in your ear, and may cause an ear infection.

Summary Statement
The project is intended to assess the effects of cell phone radiation on bacteria found in the ear, specifically staphylococcus epidermidis.

Help Received
Used lab equipment at University of California Riverside under the supervision of Dr. A.L.N. Rao and Dr. Venkatesh Sivanandam; Received materials and consultation from Dr.Aman Mann; Deepta Dhillon helped with the display; Dr. Bita Bagheri provided consultation

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)
Joshua E. Eyre

Project Number
S1509

Project Title
Bactericidal Effects of Photosensitizers and Low-Power Lasers on E. coli

Abstract

Objectives/Goals
One of the biggest problems faced by our society is antibiotic resistant bacteria. One alternative antimicrobial strategy is photodynamic therapy (PDT), involving the use of light-activated antimicrobial agents (LAAAs). Ongoing research proposes the use of the photosensitizers (Indocyanine green (IC green), Methylene blue, and Toluidine blue O) activated by 5 mW lasers (808 nm for the IC green, 650 nm for the two blue dyes). In this experiment the three photosensitizing dyes act as LAAAs and when activated by the laser, they release free radical singlet oxygen that kills bacteria. This experiment investigates the parameters within which low-power lasers and corresponding LAAAs kill bacteria.

Methods/Materials
The effects of three different LAAAs on the bacteria (Escherichia coli) was determined by examining the zone of inhibition created by the laser and determining how much bacteria grew, if any, on plated bacteria that had been mixed with the dye and exposed to the corresponding laser. Each test was performed with several different exposure times ranging from 30 seconds to 30 minutes and different dye concentrations ranging from 100ug/l to 10g/l. Control tests were performed by growing and irradiating bacteria without any LAAA present to determine if the laser by itself had any bactericidal effect. A measurement of the zone of inhibition was recorded to determine the effectiveness of each tested application.

Results
The results clearly show that E. coli can be killed with low-power lasers and either Methylene blue or Toluidine blue, but not with Indocyanine green. It also shows that both time of laser exposure and concentration of LAAA are important, but that the time of irradiation is slightly more important in most cases. It also shows that Methylene blue and Toluidine blue are equally effective.

Conclusions/Discussion
This research has documented the effectiveness of these lasers coupled with the appropriate LAAA; however, further research is required to discover the minimum strength of the laser and the minimum concentration of dye that is still effective.
Real life applications from this experiment include utilizing this treatment for localized antibiotic resistant infections colonizing in hospitals or other places that commonly harbor antibiotic resistant bacteria, and for use with chronic pressure sores and open wounds.

Summary Statement
This project measures the relative effectiveness of laser-activated dyes as antimicrobial agents to kill the bacteria E. coli.

Help Received
Parents helped keep time with stopwatch; Dr. Southwell helped answer questions about lasers; Used lab equipment at Thousand Oaks High School under Dr. Malhotra; Dr. Wilson gave advice on experiment design; Drs. Statner, Beard, and Valusek provided bacteria and antibiotic advice; Dr. Steinhauer donated

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)

Elan E. Filler

Project Number

S1510

Project Title

Transcription Factors that Regulate Antimicrobial Resistance in Candida glabrata

Abstract

Objectives/Goals

The fungus Candida glabrata is part of the normal human flora. In hospitalized patients with weakened immune systems, the fungus can enter the bloodstream from the GI tract and cause a serious, frequently fatal infection. Both white blood cells and cells lining the GI tract contain antimicrobial peptides that kill C. glabrata and prevent infection. Patients infected with C. glabrata are treated with the antifungal drug, caspofungin, but some strains are resistant. My hypothesis is that C. glabrata has specific transcription factors that enable it to resist antimicrobial peptides and caspofungin.

Methods/Materials

To identify these transcription factors, a collection of C. glabrata mutants, each of which lack a different transcription factor, was screened for increased susceptibility to the antimicrobial peptide, protamine, or the antifungal drug, caspofungin. The ability of each mutant to grow on agar plates containing either protamine or caspofungin was compared to the control, wild-type strain. Mutants that were susceptible to either compound, as compared to the control strain, were retested to verify the results. Using bioinformatics, the genes that were absent in the susceptible mutants were searched in the Candida Genome Database to determine their function.

Results

Of the 91 C. glabrata transcription factor mutants that were tested, 3 were susceptible to protamine only and 6 were susceptible to caspofungin only. Seven mutants were susceptible to both protamine and caspofungin. Notably, 3 of these 7 mutants lacked Spt8, Ada2, or Gcn5. My bioinformatics research revealed that in other organisms, these proteins are known to form part of the SAGA histone acetyltransferase complex. This complex acetylates histones, exposing DNA and leads to the transcription of downstream genes that are responsible for resistance.

Conclusions/Discussion

Therefore, the Spt8-Ada2-Gcn5 complex plays a key role in governing the ability of C. glabrata to resist both antimicrobial peptides and caspofungin, and is a promising target for new antifungal drugs.

Summary Statement

I found that the SAGA histone acetyltransferase complex governs the resistance of the fungus, Candida glabrata, to antimicrobial peptides and caspofungin.

Help Received

Used lab equipment at the Los Angeles Biomedical Research Institute under the supervision of Dr. Liu.

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)

Joyce Huang; Neymika Jain

Project Number

S1511

Project Title

The Effect of Chemosensitization on the Efficacy of Antifungal Agents

Abstract

Objectives/Goals

Fungal agents have shown increasing signs of resistance towards regularly used antimycotic agents. With our research, we hope to find a combination of both antifungals & natural chemosensitizers that may potentially benefit the medical & agricultural community.

Methods/Materials

The antifungals tested included Azoxystrobin & Difenoconazole, which are commonly applied on cereals & grains. For our chemosensitizers, we chose Thymol & 4-HBA. In order to study the effects of the drugs combined with the chemicals, the fungus, fusarium oxysporum, was grown on potato dextrose agar supplemented with concentrations of the sensitizers or various doses of the antifungals. After performing qualitative research, we decided the final concentrations and measured percentage of growth in order to compare data. In order to conduct our research, we used 42 Petri Dishes, a mixture of hydroxide & methanol, ethanol, Difenoconazole, Azoxystrobin, Thymol, 4-HBA, Potato Dextrose Agar, and fusarium oxysporum.

Results

The combination of Azoxystrobin & 4-HBA showed little inhibition. By adding Thymol with lower dosage, inhibition was showcased but was not the most effective group. With higher dose, there was more growth compared other Azoxystrobin experiment groups. With the Difenoconazole & 4-HBA experiment groups, growth was significantly more than all other combinations. With Thymol, both experiment groups' growth only began on the eighth day of observations, but lower dose showed more inhibition.

Conclusions/Discussion

After experimentation with different combinations of various antifungal agents & chemosensitizers, the combination of Difenoconazole & Thymol most effectively inhibited growth. We also discovered that growth with the application of lower antifungal dose seemed more effective when combined with chemosensitizing agents. Overall, against Ascomycota fungi, the project revealed that combinations of chemosensitizers with antifungals did increase the efficacy of antimycotic activity. For further research, we could focus on the concentration & amount of dosage in order to determine whether there is a correlation between lower doses & higher efficacy with natural compounds as well as experiment with other fungi in the Ascomycota section and later branch to other fungal sections.

Summary Statement

Our project determines the most effective combination of an antifungal and a natural compound as an ideal antimycotic treatment to inhibit fungal growth.

Help Received

Used lab equipment at Harker under Dr. Blickenstaff. Dr. Blickenstaff helped pour agar into plate while my partner and I pipetted the antifungals and chemosensitizers. Printed board at Kinkos

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)

Gokul V. Kalyanasundaram

Project Number

S1512

Project Title

E. diabli: A Synthetic Biological Approach for Tackling Type 2 Diabetes

Abstract

Objectives/Goals

Type 2 diabetes is an illness where an adequate amount of insulin is not produced.Current treatments for diabetes require constant monitoring of blood glucose through injections of insulin or other hormones. My goal was to engineer an E. Coli that would live in the human gut to sense high levels of glucose and then produce and secrete the hormone GLP-1 which would stimulate the production of insulin which lowers blood glucose levels. I designed two plasmids: one that can sense high levels of glucose and generate and secrete GLP-1 and a control that would generate and secrete GLP-1 constitutively.

Methods/Materials

First, I performed the transformation to insert my plasmids into the E. coli. Next, I cultured the transformed bacteria on plates that contained the antibiotic Ampicillin which allowed only the transformed bacteria to grow to check if the transformation had worked. Next, I subcultured the transformed bacteria in 5 different conditions which corresponded to different levels of blood glucose. After this, I centrifuged the bacteria to separate the supernatant from the pellet which I then lysed. Lastly, I performed the ELISA to find exactly how much GLP-1 had been produced and secreted.

Results

The E. Coli with the constitutive promoter constantly produced an average of 600 pmol of GLP-1 and secreted an average of 180 pmol of GLP-1. It was not affected by the amount of glucose in which the E. coli was given to grow in. However, E. diabli (E. coli with the glucose sensing) produced varying amounts of GLP-1 based on the amount of glucose it grew inside. When the bacteria was grown in the medias that corresponded to none and low amounts of glucose, it secreted around 20 pmol of GLP-1, a very small amount. When it was grown in the medias corresponding to normal, diabetic, and extremely high amounts of glucose, it secreted up to 200 pmol of GLP-1, an ideal amount.

Conclusions/Discussion

My hypothesis was fully supported since E. Diabli secreted an ideal amount of GLP-1 when it was subjected to normal, high, and diabetic levels of glucose. Since only around 10%-15% of the GLP-1 (20 pmol) will actually reach the liver, this solution is perfect. On the other hand, my control plasmid with the constitutive promoter generally produced a constant amount. Clearly, this work is very promising and opens up a very new way of treating Type 2 diabetes.

Summary Statement

This project was about engineering a bacteria to constantly monitor the blood glucose levels diabetic patients by changing the behavior of an E. coli to make it sense high levels of glucose and secrete a hormone to control the high levels.

Help Received

Mother helped me conduct research; Used lab equipment in Schmahl Science; Dr. Aru helped answer questions; Dr. Sam watched over my experiment

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)
Janie Kim

Project Number
S1513

Project Title
A Study of Contact Lens Solution Preservatives as a Potential Treatment for MRSA and Pseudomonas Infections

Abstract

Objectives/Goals
The objective was to continue testing five select contact lens solutions against P. aeruginosa, and to see how low the lens solution preservatives Chlorhexidine Gluconate and Polyaminopropyl Biguanide could be diluted while still remaining effective antimicrobial agents against MRSA and Pseudomonas.

Methods/Materials
Part 1: P. aeruginosa was diluted to an optical density of 0.40 in phosphate buffered saline using a spectrophotometer, and this suspension was then diluted to 1:20. The solutions were serially diluted with CA-MHB, and10 µl of the prepared bacterial solution was added. The plates were incubated, then resazurin was added. The experiment was repeated three times.
Part 2: The bacteria were prepared with the same methods as in Part 1. CHD and PAPB were serially diluted, then 10 µl of the bacterial solution was added to the wells. The plates were incubated. The MRSA and Pseudomonas trials were run separately.

Results
Part 1: Menicare was most effective in discouraging growth of P. aeruginosa than any of the other tested solutions, and the average percentage in which bacteria began to grow was 9.375%. Boston Advance and Simplus averaged 11.25%. Lobob and Opti-Free 18.75%, and the saline control 45%.
Part 2: Against MRSA, CHD and the combination averaged 0.000125% and PAPB averaged 0.0001875%. Against Pseudomonas, CHD and PAPB averaged 0.001% and the combination averaged 0.0005%.

Conclusions/Discussion
Part 1: None of the solutions performed as well against Pseudomonas as they had against MRSA. This data suggests that it is more difficult for the preservatives to kill Gram-Negative bacteria than Gram-Positive.
Part 2: The preservatives did not eliminate bacteria at percentages as low as hypothesized, possibly due to being isolated from the rest of the contact lens solution's ingredients. The next step would be to discover whether these concentrations are safe for human internal use.

Summary Statement
My project looks into the antiseptic ingredients in contact lens solutions as a potential treatment for MRSA and Pseudomonas infections, and is working toward finding a way to effectively do so.

Help Received
Used lab equipment at UCSD under the supervision of Dr. Victor Nizet and Mr. Leo Lin; Mrs. Elaine Gillum helped edit research paper; Parents bought contact lens solutions; Mother helped glue board together

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)
Mary Y. Liu

Project Number
S1514

Project Title
Potential of Nitric Oxide to Control Escherichia coli Bacteria

Abstract

Objectives/Goals
The objective of my project is to determine whether nitric oxide gas has any effects on Escherichia coli, and the effects of duration of treatment, temperature, and nitric oxide concentrations on the results.

Methods/Materials
Agar plates inoculated with E. coli bacteria were placed in fumigation chambers and were fumigated with nitric oxide gas under ultralow oxygen conditions for different durations, under different temperature, and with different concentrations of nitric oxide. Each treatment was replicated 4-6 times. Afterwards, the inoculated agar plates were incubated at 30°C for 24 hours to determine the effects of nitric oxide fumigations on the growth of the E. coli by comparing its growth to the controls and controls under ultralow oxygen conditions.

Results
Nitric oxide was found to have some inhibitory effects on E. coli. Fumigation was also found to be most efficient when given a longer treatment period and higher nitric oxide concentrations. No complete inhibition was achieved however.

Conclusions/Discussion
Nitric oxide has some inhibitory effects on E. coli bacteria, but can not completely kill the bacteria. Nitric oxide fumigation, when used for other purposes, may have additional benefits when inhibiting the growth and development of bacteria.
Character

Summary Statement
The purpose of my project is to determine the effects of nitric oxide fumigation on Escherichia coli and its efficiency.

Help Received
Dr. Yongbiao Liu- guided and assisted in project, provided lab space and equipment

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)
Michelle H. Park

Project Number
S1515

Project Title
Phytohormone Indoleacetic Acid: A Natural Cure for Fungal Infections of the Human Scalp?

Abstract

Objectives/Goals
Recent research reveals that select phytohormones seem to have significant antibacterial properties and cause plant resistance to fungal disease, but little light is shown on the details of this phenomenon. Meanwhile, fungal infections of the scalp continue to afflict humans worldwide, causing conditions such as Tinea capitis, folliculitis (and subsequently hair loss), and even dandruff. Thus, the objective of this experiment was to determine if the phytohormone indoleacetic acid (IAA) has any inhibitory effects on fungal cultures grown from dandruff samples. My hypothesis was that the petri dishes treated with the highest concentration of indoleacetic acid would show the least amount of fungal growth.

Methods/Materials
In this experiment, petri dishes with samples of fungi procured from dandruff samples were cultured with filter discs soaked in differing concentrations of IAA. After three days of incubation, percent area of fungal growth was calculated.

Results
My hypothesis was annulled by the results of the experiment, which showed that indoleacetic acid (IAA) promoted rather than inhibited fungal growth as concentration increased. As its concentration increased, IAA drastically promoted rather than inhibited fungal growth. Fungal plates treated with the highest concentration of IAA (500 micromolar IAA) showed an average of 295% more growth than fungal plates treated with distilled water (0 micromolar IAA).

Conclusions/Discussion
These findings are significant in contributing to the argument against the antifungal properties of phytohormones and instead attributing fungal resistance of plants to the plant health-promoting aspects of indoleacetic acid rather than direct fungal inhibition. Data from this research also reveals a deeper role of chemical communication between plant-fungal interactions.

Summary Statement
This project's focus was to investigate the potential of indoleacetic acid as an inhibitor of dandruff-derived fungal growth.

Help Received
Mother helped glue together display board; Mrs. Ramirez-De La Cruz answered questions about science fair.

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)
Akshar G. Patel

Project Number
S1516

Project Title
Libraries: Keepers of Knowledge or Convents of Bacteria?

Abstract

Objectives/Goals
My objective was to prove that library books bear high levels of bacteria which account for various illnesses. I hypothesized if I test one book from each section of the library for levels of bacteria and compare it them to the level of bacteria on the personal collection of my books at home, then the books from the library will yield a higher count of bacteria and account for more susceptible forms of bacteria and viruses.

Methods/Materials
By cultivating bacteria off of the books on nutrient agar-filled petri dishes and examining the bacteria under an electric microscope I was able to receive my results. I checked out one book from each section in the James S. Thalman Library as subjects to test and chose four books from my personal collection. For consistency and repetition, I decided to test each book three times. I tested 24 times for bacteria, 3 for each book, and left one as a control.Over a 7-day growth period I collected data for later analysis.

Results
At the end of my experiment, the average number of colonies for the books from the library was 11.5 and the average number of colonies for the books from home was 6.0. In almost every single case except one, the library books contained more colonies on the cover. Fungus was a factor visible on many of the books from both home and the library. Overall, it proved that books from the library do harbor more bacteria. The standard deviation for the library books was 7.2 and for the home books it was 3.0.

Conclusions/Discussion
My hypothesis was partially correct. The higher number of bacteria accounted as a true result. Partially this was already a question answered due to the fact that my statistics show that plenty of people come through the library system on a day to day basis. The only people that use my books are my family other than me. The factor of who uses those books is great in answering my hypothesis and affirming why it is correct. What I wasn#t able to prove was that whether the bacteria on the books accounted for higher forms of bacteria and viruses and whether they have increased susceptibility or not.

Summary Statement
My project focused around proving library books bear high levels of bacteria accounting for various illnesses, making it an unsafe environment.

Help Received
My cousin helped me design my display board.

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)
Tiffany Sae Sato

Project Number
S1517

Project Title
Can Asparagus Decrease the Growth of Saccharomyces cerevisiae?

Abstract

Objectives/Goals
Based on the previous studies, it has shown that cancer cell count or activity is decreased by the increase of compounds which contain sulfur. It is also known that asparagus produces sulfur compounds during digestion. Thus, it is expected that asparagus will have a significant effect on cancer cells and can prevent cancer cells from growing.

Methods/Materials
Since cancer cells are not readily available, Saccharomyces cerevisiae is used in my experiment, in lieu of cancer cells as S. cerevisiae cells and cancer cells share a typical eukaryotic cell structure. In addition, S. cerevisiae cells are able to reproduce at a fast rate, like cancer cells.
In order to observe the change and transformation of S. cerevisiae cells, asparagus liquid medium and asparagus agar plates are prepared. With using liquid medium, the absorbance of S. cerevisiae activity is measured with a spectrophotometer. From the agar plates, the number of viable S. cerevisiae colonies are counted.

Results
The results from my experiment with the asparagus liquid medium had the lowest absorbance, compared to my negative and positive control. Also, the results with the asparagus agar plates showed a decrease in viable colony counts.

Conclusions/Discussion
The results prove to be incredibly appealing as they clearly showed a decrease in activity and viable colony counts of S. cerevisiae when asparagus is added to the specimen, which leads to the presumption that asparagus can have the effect of preventing the progression of cancer cells.
To further this experiment, proteins that are involved in cell wall formation will be examined. Additionally, it will be studied if asparagus can inhibit the expression of the proteins involved in spindle formation during cell division.

Summary Statement
Asparagus can help the growth of cancer cell activity to decrease.

Help Received
Experium Science Academy under the supervision of Raudhah Rahman for her constant support.

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)
Layla G. Stefanacci

Project Number
S1518

Project Title
The Synergistic Effects of Antibiotics and Essential Oils

Abstract

Objectives/Goals
The objective is to compare the individual/synergistic effects of antibiotics and essential oils.

Methods/Materials
A broth dilution technique was used to count colonies after antibacterial treatment. After taking .1 mL (and .01 mL oils as well during synergistic trials) of the antibacterial agent 10 mL of contaminated nutrient broth was mixed with the . After agitating it, 1 mL of that solution and was mixed it with 9 mL of sterile/chilled nutrient broth. This cycle continued on until a 1:1,000,000 dilution. After plating these test tubes, the agar plates incubated for 24 hrs. The dilution number with a minimum colony count of 30 and a maximum count of 300 colonies was chosen. This colony count was multiplied by the dilution number to find the bacteria left after treatment.

Results
Thyme oil had the greatest effect after treatment with a range of 310,000-1,000,000 colonies. The average amount of colonies was 439,000. The oil that had the least effect was lavender with a range of 2,000,000-4,000,000. The average colony count of 3,450,000. The vancomycin had a greater lytic effect on the bacteria with a range of 180,000-250,000 colonies with an average number of 217,454. Ciprofloxacin had the lesser lytic effect with an average number of 403,636 and a range of 300,000-470,000. Thyme oil and vancomycin were the most effective antibiotic/essential oil combination.

Conclusions/Discussion
Thyme oil was the most effective oil probably because of its potency and overall antimicrobial strength. Lavender is more known for its aromatic properties and had the least lytic effect on the bacteria. The antibiotics are commercially sold as antibacterial agents which may be a reason they were more effective than the oils. Although thyme/vancomycin were the best oil/antibiotic pair, they did not have a synergistic effect. Because their lytic effect was so close to the antibiotics alone, the oils did not potentiate their overall performance. If I did this project again, I would focus more on the synergistic aspect of this experiment and would work with different concentrations of the oil to see if that potentiated the antibiotics

Summary Statement
I compared the individual and synergistic effects of antibiotics and essential oils.

Help Received
Mother, Mrs. Royce, Mr. Whittington proofread report, Mrs. Royce supervised me at the school lab, Mr. Whittington advised on procedures and methods

CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)
Avantika Vivek

Project Number
S1519

Project Title
The Effects of Neem Leaf, Calendula Petal, Burdock Root, and Turmeric Extracts on the Prevention of Hand Bacteria Growth

Abstract

Objectives/Goals
The purpose of this experiment was to determine the effects of four different herbs (neem leaves, calendula petals, burdock root, and turmeric) on their use as a viable defense against the growth of bacteria on the hands.

Methods/Materials
In this experiment, four different hot extracts, one per herb, were set up to be used as rinses, with hand soap and hand sanitizer used as two comparative washes. Three swabs were taken of the subject#s hand before washing, as controls, with ten swabs taken as trials after the subject had washed for one minute with the cleansing substance. These swabs were plated onto Petri dishes, and left to incubate for five days, after which they were removed and the colonies were counted on each plate.

Results
The percentage decreases from initial control colony averages to trial averages were that calendula had a 79.8% decrease, neem had a 92.01%, burdock had 37.27%, turmeric had 92.04%, soap and water had a 12.21%, and hand sanitizer had a 99.08% decrease. The standard deviations for the substances were that calendula had 7.75, neem had 2.90, burdock had 11.38, turmeric had 5.59, soap and water had 18.49, and hand sanitizer had 0.40.

Conclusions/Discussion
The data did not support the hypothesis, as turmeric had a 92.04% decrease from the control average of colonies, but had a higher average deviation than neem, at 92.01% decrease, whereas burdock only had a 37.20% decrease. This could have meant that although turmeric performed slightly better than neem, neem was more reliable in terms of decreasing colony growth over periods of time, while burdock did perform the least effective of the herbs tested. On the other hand, the trials done with hand sanitizer had a 99.08% decrease, as the effectiveness of alcohol-based cleansers exceeded that of the natural extracts, but it should also be considered that alcohol-based cleansers cause long-term damage to skin. Although hand sanitizer yielded the highest results, at 99.08% decrease, the effects of both neem and turmeric on the bacterial colonies represents a starting point for further research into their effects on bacteria

Summary Statement
My project is about studying the effectiveness of previously untested natural substances in the prevention of hand bacterial growth.

Help Received
Mrs. Gowri Selvan helped with experimental design and mentoring; mother was subject used; father helped to review layout and to set up incubator; Mr. Michael Antrim reviewed report