



Abstracts

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Arizona Junior Science and Humanities Symposium (AZJSHS) is a regional component of the National Junior Science and Humanities Symposium that is sponsored by the Department of Defense. The Junior Science and Humanities Symposia (JSHS) program promotes original research and experimentation in the sciences, engineering, and mathematics at the high school level and publicly recognizes students for outstanding achievement. By connecting talented students, their teachers, and research professionals at affiliated symposia and by rewarding research excellence, JSHS aims to widen the pool of trained talent prepared to conduct research and development vital to our nation.

The JSHS mission is:

- * promote research and experimentation in the sciences, engineering, and mathematics at the high school level
- * recognize the significance of research in human affairs and the importance of humane and ethical principles in the application of research results
- * search out talented youth and their teachers, recognize their accomplishments at symposia, and encourage their continued interest and participation in the sciences, mathematics, and engineering
- * expand the horizons of research-oriented students by exposing them to opportunities in the academic, industrial, and government communities
- * increase the number of future adults capable of conducting research and development

This event is to celebrate the achievements of our young investigators, to provide them an opportunity to share their research as well as their enthusiasm for science, and to make new friends from across the state.

We thank all the participants and volunteers who have made the 2016 AZJSHS a successful event. Please share this abstract booklet with your friends and colleagues and help us promote AZJSHS.

Sincerely,

AZJSHS Co-Directors

B.L. Ramakrishna

Arizona State University

Laura Hobson

Arizona State University

**The Effect of Varying on Light
and Dark Cycles on Plant Growth**

Alsaeedi, Sarah
Junior

Mesa High School, Mesa, AZ
Teacher/Mentor: Amanda Cherry

The experiment performed by the student researcher tested the effect of irregular biological clock schedule on germination of fast plants. Seeds were watered with the same amount, but the plants were divided into dark and light cycles to determine its responses of 24-hour day period, that is known as Photoperiodism. Plants can tell the time of when they are sprouting or being watered, so changing the time to irregular by testing the plants into dark and light periods to see if it helps the plants grow healthier or not in the aspect of metabolism, physiology, and behavior.

Resistance Rates in *S. aureus*

Ayala, Mariela
Senior

Mesa High School, Mesa, AZ
Teacher/Mentor: Amanda Cherry

Staphylococcus aureus causes infections in many different forms, including superficial skin lesions, abscesses, impetigo, cellulitis, endocarditis, food poisoning, and urinary tract infections. *S. aureus* is often resistant to many different antibiotics, such as penicillins, cephalosporins, and disinfectants. It is perhaps best known in the form of MRSA —methicillin resistant *Staphylococcus aureus*. It is a strain of staphylococci that is resistant to most antibiotics transmitted through direct or indirect contact. This antibiotic-resistant staph can lead to fatal diseases, including necrotizing pneumonia, severe sepsis, and necrotizing fasciitis. Since the first introduction of antibiotics, *S. aureus* has responded to new drugs by rapidly acquiring resistance by a variety of genetic mechanisms. Extensive research on resistance to antibiotics has been studied. However, there is minimal data considering the effects of naturopathic alternatives to resistance in *S. aureus*. Naturopathic medicine is used to treat or prevent illnesses or disorders with the use of natural remedies or techniques, usually in the form of herbs. For this experiment, extractions of garlic, Oregon grape root, Chrysanthemum flowers, Usnea lichen, and *Arctostaphylos uva-ursi* will be used as natural remedies. The absorbance values will be determined using a spectrophotometer to represent cell growth, and thus the effectiveness of each remedy.

Observing Drug Synergy Mechanisms to Target

Intrinsically Disordered Proteins in Viruses

Bharati, Ritika

Junior

Hamilton High School, Chandler, AZ

Teacher/Mentor: Raxha Bhagdev

An intrinsically disordered protein (IDP) is a protein that lacks a stable tertiary structure. A key aspect of such a protein is that it goes against the traditional dogma that protein structure determines protein function. IDPs, despite their unstable structure, have many applications in biology and biochemistry. Molecular recognition features (MoRFs) are regions in intrinsically disordered proteins that undergo disorder-to-order transitions by binding to different partners.

There are many hurdles to using conventional experimental methods to find drugs that can target intrinsically disordered proteins. For instance, IDPs cannot be crystallized, making it extremely difficult to formulate these proteins for large scale pharmaceutical bioassays. However, computational modeling provides an alternative to laboratory testing for drugs.

In this project, past data on MoRFs and IDPs was used to determine drug synergy mechanisms to target MoRFs and their binding partners, alongside looking at aspects of MoRFs such as biomimicry and fragment based drug discovery. The predicted drugs proved to be more effective than current antiviral drugs, as the predicted drugs had a higher binding affinity towards their targeted binding site as opposed to their commercial counterparts. This method saves time, energy, and fiscal resources for future drug discovery endeavors.

Bringing Justice To Steven Avery: Analyzing Acid Detection-Based

Ethylenediaminetetraacetic Evidence in a Criminal Investigation

Bimrose, Jacob

Senior

Brophy College Preparatory, Phoenix, AZ

Teacher/Mentor: Cheryl Lenox

Making a Murderer is a Netflix documentary series about Steven Avery, a man wrongfully charged with sexual assault who spent 18 years in prison before being exonerated, but later convicted of first-degree premeditated murder. The objective of this study was to find if the presence of Ethylenediaminetetraacetic acid (EDTA) chelates in solution could become negligible after exposure to sunlight. EDTA is an anticoagulant contained in the same brand of blood tubes that was used to draw the blood of Steven Avery in 1997. Years later it was discovered that the tube containing his blood was broken into, eliciting the allegation that blood was planted in the victim's car. I had to research the nature and chemistry of EDTA, find out how to mimic the UV intensity of sunlight using the inverse-squared law, and detect the EDTA after exposure. The relationship I found between time exposed to UV light and molarity of the EDTA solution was -0.01274 mol/L/min. At that rate it would take only 11.3 seconds of sunlight for all Calcium-EDTA in the samples to completely degrade, calling into question the accuracy of the FBI's conclusion that blood was not planted at the scene of the crime.

Using an Isolated Gain System to Heat a Traditional Home

Charley, Kelly
Junior

Navajo Preparatory School, Farmington, NM
Teacher/Mentor: Yolanda Flores

Rural communities across Native American reservations are held back by traditional heating sources like coal and wood. This project serves to provide an alternative heating source for these communities. The aim was to create a system that would be available to individuals in struggling communities by addressing major barriers like cost and availability. The passive system utilizes radiation from the sun to transfer heat energy. Antifreeze inside the system is circulated by thermal convection. Warmed antifreeze is displaced to force colder antifreeze back inside the system. This process continues as the day progresses, warming the traditional Navajo home or Hogan.

Control testing was recorded for two days. Trial testing was recorded for three days. The hypothesis, if an isolated gain system is constructed with an aluminum backing, 3/8inch copper tubing, and sealed with a tempered glass sheet, then the system will produce the highest temperatures, was not supported. An Arduino microprocessor was programmed to document the temperatures from three sensors. Outdoor temperatures were documented from online weather services. Data collected demonstrated some correlation in heat rise during the coldest time periods however, optimal heat transfer was not evident in the data collected, therefore the hypothesis was not conclusive.

**The Effectiveness of Chemical and on
Physical Interference Ultraviolet Radiation**

Covo, Danijela
Junior

Mesa High School, Mesa, AZ

Teacher/Mentor: Dr. Tamara Kashiwada/ Ms. Amanda Cherry/ Ms. Amand

This experiment was done to test the effectiveness of chemical sunscreen filters in comparison to physical sunscreen filters. The chemical sunscreen's main component was oxybenzone whereas that of the physical filter was titanium dioxide and zinc oxide. Physical sunscreens block UV radiation by reflecting it off the skin whereas chemical sunscreens absorb the radiation and disperse it as heat onto the skin of the user. The effectiveness of the varying filters ability to interfere with ultraviolet radiation was tested on the model organism *Escherichia coli*. The growth of the culture was measured by increased concentration using a spectrophotometer. The results showed that the chemical sunscreen filter maximized growth when compared to the physical sunscreen. In conclusion, both the chemical and physical sunscreens interfered with the ultraviolet radiation. There are many trade-off qualities that one may deal with when choosing a physical or chemical sunscreen. Ultimately, it is up to personal preference and whether one would trade off greater coverage for reduced skin irritation or vice versa.

Searching for Trends and Susceptibility in Canines for

Diagnosed Positive *Coccidioides* spp. in Tucson, Arizona

Darby, Morgan

Senior

Tucson High Magnet School, Tucson, AZ

Teacher/Mentor: Margaret Wilch

Coccidioidomycosis, commonly known as valley fever, is a fungal disease endemic to the Southwestern United States. Coccidioidomycosis is caused by dimorphic soil borne fungi, belonging to the family Onygenaceae, the spores of which are inhaled by the host. The fungal infection originates in the lungs and disseminates, causing a multitude of symptoms and varies in infection severity. Previous research, involving a large geographic region, determined that coccidioidomycosis annually affects 4% of the canine population in Pima, Pinal, and Maricopa counties in Arizona. No trends to date have been found in canines diagnosed positive for coccidioidomycosis. This study focused on a small centralized location, Pima County, and looks at trends between dog age, breed, titer, antibodies Immunoglobulins G (IgG) and M (IgM), and symptoms for dogs positive for coccidioidomycosis. Of 150 dogs, all were positive for antibody IgG, 115 were negative for IgM, and 26 were positive for IgM. No trends were found between age and titer, or weight and titer. When looking at symptoms, most dogs (approx. 62 percent) have only one reported symptom, with titers between 1:8 and 1:32. When looking at titer by American Kennel Club breed groupings, Toy, Terrier, and Working have titers clustered between 1:4 and 1:32.

Programming NANORGs

Gabaldon, Israel
Junior

Navajo Preparatory School, Farmington, NM
Teacher/Mentor: Yolanda G Flores

The purpose of the research was to understand NANORG coding in a better and more effective way. The researcher would like to test which part, SafEat or CloneDrone of the Chronos, Bryant Brownell, Oregon State University code is more effective using the Conest06 program. The hypothesis was that if the researcher will test the parts of the code using Conest06 program, then the CloneDrone will be more effective.

The researcher used Conest06 program, and the Chronos code using a computer. It was tested by “cutting” the parts of the code and ran them separately. Then scores were gathered from the Conest06 program. If the score is higher, then it is more effective.

The hypothesis was accepted. The CloneDrone part was more effective part between the two. The scores were higher at 271,758, 872.

A Novel Graph Theory Based Approach for Identifying Drug Discovery

Targets in Computationally-Derived Gene Regulatory Networks (cGRNs)

Iyer, Dhruv

Junior

Hamilton High School, Chandler, AZ

Teacher/Mentor: Dr. Gil Speyer

Analysis of Computationally-derived Gene Regulatory Networks (cGRNs) can accelerate drug discovery. Evaluation of Differential DependencY (EDDY) determines if a metabolic pathway differs significantly between two classes of cells (e.g. wild-type and mutant). This research extends EDDY by incorporating five measures of centrality (Clustering, Distance, Betweenness, Closeness, Eigenvector) and three measures of connectedness (Diametric difference, Kolmogorov-Smirnov Test, Probability Degree Distribution) to identify genes of influence in cGRNs. Data from cells previously treated with drugs, known to target particular genes, was retroactively analyzed using a 26-neuron Bayesian Classifier Neural Network (NN), which used the metrics to identify gene targets that would most effectively disrupt the cellular pathways. The identified genes were then compared against the actual target of the drug to validate the metrics. 48 metabolic pathways from CCLE samples were analyzed, and 24 were used to validate the neural net's predictions. In 15 of these pathways, the NN predicted the correct target. For example, the NN predicted that targeting HDAC3 would disrupt the RELA network and that targeting BCL2 would disrupt the P53 pathway, which are the targets of PANDACOSTAT and NAVITOCCLAX respectively. This success suggests that metrics based on graph analysis are powerful tools to aid in identifying drug targets.

A Novel Solution for the Visually Impaired, Phase 2

Kandan, Mani
Junior

Hamilton High School, Chandler, AZ
Teacher/Mentor: Dr. Angela Sodemann

The most recent census showed there were 21.2 million Americans suffering from vision loss. Being visually impaired has many disadvantages, especially while traveling. Most assistive devices use ultrasonic or image-capturing sensors; some are extremely primitive such as white canes. One approach to help visually-impaired individuals is to provide visual information through a different sense. These devices convert image information to haptic (touch) feedback. My assistive device is portable, concealable, and economical.

The use of piezoelectric ceramics as a medium of tactile communication for visual information was investigated. Two different 'ceramic-patches', each with a unique setup (28x28 and 40x40 ceramic-squares) were created to be worn by the user. The ceramic patches were programmed to communicate information about the user's environment obtained from the user's Android cellphone's camera (Nexus 5) to four PSoC 'Gumsticks'. Each PSoC gumstick activates individual piezoelectric filaments worn by the user; the filaments move across the user's wrist to create the sensation or shape of the targeted object from the user's environment. The number/resolution of filaments and location of the ceramic-patch on the user's body will be tested to determine its impact on the user's ability to identify the presence and location of nearby objects and avoid collisions.

Antimicrobial Properties of Ascorbic

Acid Treatment against Escherichia Coli K-12

Khurana, Rohit

Freshman

Brophy College Preparatory, Phoenix, AZ

Teacher/Mentor: Ms. Cheryl Lenox

The purpose of the project is to elucidate ascorbic acid treatment as a means of inhibiting Escherichia Coli growth. Minimum inhibitory concentration (MIC) as well as the synergy between antibiotics was tested at 30 mg/mL, 3 mg/mL, and 0.3 mg/mL concentration. Its presence in inhibiting growth was determined by the Kirby-Bauer disc diffusion technique and measured through the area of zone of inhibition. Discs with solution compote were placed on blood agar plates (in vitro) and incubated for 1 day with a span of 2 days thereafter at room temperature. After the time span, the use of the ascorbic acid (at all concentrations) had no effect on the growth of the bacterial cultures. When coupled with antibiotics, results showed no deviation from the antibiotic tested alone, indicating that ascorbic acid has no synergistic effects. However, the results perhaps indicate that there is a misconception that ascorbic acid directly fights off foreign pathogens but instead could act more indirectly. This project was based on the potential significance it could have in terms of enhancing or even substituting the use of antibiotics.

A Low-Cost, Flying Life Detection System of for the Recovery Victims After Earthquakes

Konan, Sachin
Sophomore

Hamilton High School, Chandler, AZ
Teacher/Mentor: James Aberle

Earthquakes are devastating natural disasters which affect regions all around the world. One of the largest issues is that first-response teams struggle to recover victims buried under piles of destroyed infrastructure. A low-cost, mobile system must be devised to solve this issue. The main indicators of life include respiration, heart-rate, and electric potential pulses. Doppler radar was chosen as a viable detection system because of its ability to detect minute oscillations, such as respiration and beating of the heart. Co₂ monitoring was applied as an added security for human surface-detection. A \$5 Doppler radar module was selected called the HB-100. Due to low-voltage and noisy output waveform, a 40dB amplifier and low pass filter were engineered. The signal was acquired and interfaced with MATLAB with a C++ code. In MATLAB, various frequency spectrum representations were tested for visually representing the data. The MUSIC algorithm was chosen and implemented for its ability to estimate frequency estimations with Gaussian noise. Co₂ monitoring was implemented with a gas sensor, and displayed in a MATLAB GUI with the radar. Future Research includes employing a power amplifier for barrier penetration, and low noise amplifier to reduce the Signal to Noise Ratio of the received signal.

**Comparison of Aminoglycoside Polymers and Lipopolymers for of
Transgene Delivery TRAIL protein into UMUC-3 bladder cancer cells**

Navale, Vedik
Sophomore

Hamilton High School, Chandler, AZ

Teacher/Mentor: Mentor: Dr. Kaushal Rege, Professor at ASU, Teache

Polymers that form polymer-DNA complexes (polyplexes) have been established to be safer and more effective -without causing death to harmless cells- than Chemotherapy and viral-mediated transgene delivery. This project investigates three Aminoglycoside polymers: Paromomycin Glycerol diglycidyl ether (PG), Apramycin glycerol diglycidyl ether (AG), and Neomycin glycerol diglycidyl ether (NG), and their lipid conjugates or Lipopolymers (aminoglycoside polymers with two 18-carbon chains): PG-C 18, AG-C 18, NG-C 18, for in-vitro transfection efficiency (delivery and effectiveness) of plasmid-DNA that encodes for a promising anti-cancer protein: Tumor-Necrosis-Factor-(TNF)-Related-Apoptosis-Inducing-Ligand (TRAIL). Efficiency is compared with a plasmid-DNA encoding for Green Fluorescent Protein (GFP) which is harmless to cancer cells. The gene encoding for GFP in the plasmid-DNA is replaced with gene encoding for TRAIL to make for controlled comparisons. Efficiency of each polymer was tested at two polyplex ratios (25:1, 50:1) on UMUC-3 Bladder cancer cells. An ideal polymer would show high GFP count or transfection (delivery level) via fluorescence, baseline of high cell viability with GFP which indicates low polymer toxicity, and effective TRAIL-induced death (shown by drop in cell viability for TRAIL vs GFP). According to data collected, NG-C 18 (at both ratios) showed highest efficiency, and is an ideal candidate for future research.

**Examination of the 5-SNPs Prediction System for
the Purpose of Application in the Forensic Research**

Navari, Ladan
Senior

Tucson High Magnet School, Tucson, AZ
Teacher/Mentor: Margaret Wilch

Human eye color prediction is important in forensic research, because of the fast decomposition of the pigment related remains. The purpose of this research was to design an experiment, in which 5 SNPs were tested to see if eye color phenotype can be predicted from the least number of SNPs. Due to the high price of sequencing, being able to find the smallest number of SNPs possible that would help us predict eye color with a low error rate, would make the method more useful in forensic research. The DNA of eight participants was collected using buccal swabs, and isolated with Wizard Genomic DNA Purification Kit. DNA was amplified using 5 different primer sets for the following SNPs rs12913832, rs6119471, rs16891982, rs12896399, rs12203592. DNA was sequenced and sequences were confirmed to match target areas using BLAST. Although the eye color of the participants could not be predicted, it can be concluded that none of the green or blue eyed participants had the rs12203592 T/T allele, so they must have the rs12913832 G/G and rs12896399 T/T for blue eye colors and the rs12913832 G/G and rs16891982 C/C to have green eye colors. Future results could be made stronger with a larger sample size.

Investigating Novel Bacteriophage Solutions as a Measure

Sanitation Against Biofilms in Medically Relevant Settings

Nejat, Aryasp

Junior

Hamilton High School, Chandler, AZ

Teacher/Mentor: Deborah Nipar

Bacteriophages have long been known to be capable of eliminating deadly bacterial infections, but their use on biofilms has been limited. In this investigation, bacteriophages were identified that are specific to *H. pylori*, MRSA, *V. cholerae*, and *C. tetani*, and were combined in a cocktail solution. These are all bacteria commonly found in biofilms in medical settings. In this preliminary stage of the experiment, various sanitation solutions of differing phage concentrations were tested on colonies of 4 different planktonic (free-floating) solutions of bacteria. Four different concentrations of phage were tested: 10^6 PFU/mL, 10^7 PFU/mL, 10^8 PFU/mL, and 10^9 PFU/mL. In addition, 4 different nutrient solutions containing various essential amino acids were tested. The efficacy of the phages was measured through counting the plaque forming units in the planktonic solutions. The results displayed that the combination of added isoleucine and a high concentration of the bacteriophage cocktail (10^9 PFU/mL) allowed for the greatest viral proliferation, and in turn, most bacteria destroyed. The next stages of experimentation call for the introduction of laser-generated shockwaves and UV radiation to the sanitation treatment, in addition to testing the identified bacteriophage on biofilms rather than planktonic solutions.

Effects of the Animas and San Juan River water

on the Mitotic Index of Allium cepa Root Tip.

Nez, Sunny

Junior

Navajo Preparatory School, Farmington, NM

Teacher/Mentor: Yolanda G Flores

The purpose of this research was to test for the effects of Animas and San Juan River water one month after the Gold King Mine spill on the mitotic index of Allium cepa root tip. The hypothesis is if the Animas and San Juan River have fair to poor water qualities, then there will be cell aberrations and the mitotic index of Allium cepa will be lower. Water samples were collected after the Gold King mine spill. Five green onions were soaked in these water for one month. After a month, onion root tips were prepared using simple micro technique and observed under a digital microscope at 400X for different phases of mitosis. Non-dividing and dividing cells were counted to measure the mitotic index and cell aberrations were also observed. These samples were compared to a control which is a prepared slide of Allium cepa.

The hypothesis was accepted, both Animas and San Juan River water affected the mitotic index of Allium cepa root tip. Cellular aberrations were observed because not only was there 0% mitotic index, the cells were also elongated, longer and they have thicker cell walls.

**Field Testing and Water Quality Analysis of the Navajo Nation and
San Juan County: Before, During and After the Gold King Mine Spill**

Nicolay, Tyra
Junior

Navajo Preparatory School, Farmington, NM
Teacher/Mentor: Yolanda Flores

On August 5th, 2015, the United States Environmental Protection Agency investigated the Gold King Mine. The heavy equipment they were using disturbed a plug made of soil at the mine entrance, releasing three million gallons of acid mine drainage into the Animas River. The hypothesis was that physical, chemical, and biological contaminants would be present in the Navajo Nation and San Juan County Rivers at different sites, and that the water quality index would be fair to poor (0-50). To support the hypothesis, research was conducted on the physical, biological and chemical characteristics of the rivers. A visual data survey was conducted at each sample site. Eight contaminant tests were conducted for the water quality index and nine tests were conducted for heavy metal concentration.

Based on the results of this study, it can be concluded that the Navajo Nation and San Juan Rivers varied in physical, biological and chemical characteristics. The water quality results before the spill show that the rivers had an average water quality rating; therefore, the hypothesis was rejected. However, poor quality results were obtained during and after the Gold King Mine Spill due to heavy metal concentrations, supporting the hypothesis.

Synechocystis PCC 6803 Growth Optimization

Pangan, Angelica
Senior

Mesa High School, Mesa, AZ
Teacher/Mentor: Teacher

The experiment performed by the student explored the relationship between surface area and volume in cyanobacteria cultures to determine if there was a way to maximize growth, especially to extend the exponential phase of cell growth. *Synechocystis* PCC 6803 cultures were grown until they began their stationary phase. The dense cultures were then distributed to new containers so that they had surface area to volume ratios of 1 square centimeter: 1 mL, 1 square centimeter: 1.5 mL, and 1 square centimeter: 2 mL. Of the total volume of the new cultures, 10% was fresh media to encourage new growth. The cultures' changes in concentration was recorded in 24-hour periods over three days. The greatest growth occurred in the cultures growing with 1 square centimeter: 1.5 mL. Its concentration increase was about 37% greater than the other two groups. Further testing with more surface area to volume ratios are required to be able to make conclusive inferences from this data.

The Effects of Demographics on Drug Presence in Public Areas

Patterson, Chenoa
Senior

Mesa High School, Mesa, AZ
Teacher/Mentor: Amanda Cherry

The purpose of this experiment was to determine whether or not if demographics influence drug presence in public areas. It was predicted that if demographics do have direct influence on public areas then areas with younger populations will experience an increase in presence of drugs. When obtaining a drug testing kit it was noted that the kit must test the surface of the object. Once acquired each city is tested in multiple public locations to gain a variety of results. Public areas chosen were determined by public access to inhibit any legal affiliations that might occur. Each city was tested in the same areas to avoid any varying factors and provide a constant in the experiment. The data gathered was able to support the hypothesis. Since there was a considerable amount of drug presence found in each area present. Other wise another known contributor that may have influenced the experiment was the residue found in public areas, this residue could have been easily transferred from another location to the tested area. Research involved followed protocol with disposing of the drug test and wearing proper protective equipment.

**A Multicenter Study of the Impact of Institutional Volume on
the Success of Transcatheter Aortic Valve Replacement (TAVR)**

Pershad, Yash
Junior

BASIS Scottsdale, Scottsdale, AZ
Teacher/Mentor: Dr. Michael Morris

Transcatheter aortic valve replacement (TAVR) is a procedure to treat aortic valve stenosis in patients unable to undergo surgical valve replacement. It is unknown whether success of TAVR is influenced by the volume of TAVR performed at a given institution. The purpose of this research is to compare success of TAVR at high, intermediate, and low-volume centers based on procedural outcomes (PO) and computed tomography angiography (CTA) measurement accuracy.

Within the Banner hospital system, patient data from one of each type of center were collected. PO are measured by mortality, stroke, kidney failure, pacemaker implantation, and hospital readmission within 30 days. Accuracy of CTA measurements was defined by the agreement of aortic annulus diameter measured by independent reviewers.

PO and CTA measurements were significantly better for high-volume centers compared to low- and intermediate-volume centers. Only 38% of patients from the high-volume center had one of the aforementioned complications, while 50% and 76% from intermediate and low-volume centers did ($p = 0.01$). CTA measurements at high-volume centers exhibited higher correlation with independent reviewers than those at low and intermediate-volume ones ($R = 0.96 > 0.34 > 0.31$).

These results support rational dispersion of TAVR instead of performing it at every hospital.

Detection of Plasmodium falciparum

Parasites in Digitized Blood Samples

Ramesh, Rahul

Junior

Hamilton High School, Chandler, AZ

Teacher/Mentor: Mrs Debbie Nipar

While malaria has been eradicated in the United States since 1951, it affects almost 200 million worldwide, killing half a million a year in developing regions of the world. The disease occurs when mosquitos inject Plasmodium falciparum into the bloodstream of a human. Malaria is easily treatable when detected; however, it continues to ravage developing areas due to a lack of high-quality equipment and well-trained technicians. Recent advances in technology have resulted in the development of low-cost, smartphone-based microscopes for use in underdeveloped areas. However, these devices still need trained technicians to analyze the blood samples. In this project, an algorithm was developed that automatically analyzes digitized images of Giemsa-stained blood samples to identify the presence of P. falciparum in the blood and calculate the parasite load. Using local binary pattern-based feature extraction and a cascade-based multi-stage classifier, the algorithm identifies the presence of infected erythrocytes and counts the amount of detected parasites. The ratio of infected erythrocytes to uninfected ones is used to diagnose malaria. Testing of the algorithm on 10 infected and uninfected patients shows that the algorithm demonstrated 100% sensitivity (true positive rate) and 100% specificity (true negative rate). The work has the potential of creating an inexpensive but reliable malaria diagnosis tool that can potentially save millions of lives, especially those of children in underdeveloped countries.

**Applying Viral Nanoparticles in a Treatment Vector for
Alzheimer's Disease Using Molecular Dynamics Simulations**

Rudrapatna, Akshata
Senior

Hamilton High School, Chandler, AZ
Teacher/Mentor: Debbie Nipar

A severe neurodegenerative disease, Alzheimer's disease currently affects about 5.3 million people in the United States. Many drugs for this disease cannot bypass the blood-brain barrier without significant modification, reducing their efficacy. The objective of this research therefore revolves around determining a viral vector capable of interacting with the blood-brain barrier and delivering drug molecules to specific targets in the Alzheimer's brain. By using molecular dynamics simulations, models of the cowpea mosaic virus (CPMV) capsid's interactions with two critical proteins, vimentin and tight-junction protein ZO-2, were developed, and the CPMV capsid was identified as an effective viral vector for treating Alzheimer's disease.

Developing Microsatellites to Identify the Range of the Water

Endangered Huachuca Umbel (*Lilaeopsis schaffneriana* ssp. *recurva*)

Russum, Ripley
Senior

Tucson High Magnet School, Tucson, AZ
Teacher/Mentor: Nadja Anderson

In recent years environmental DNA and microsatellite techniques have been applied to simplify and strengthen the monitoring abilities of endangered organisms. This Project focuses on the application of these techniques to detect the presence of Huachuca Water Umbel, an endangered species in the Apiaceae family that is endemic to Southeastern Arizona. Feasible monomorphic microsatellites were identified with the help of the National Center for Biotechnology Information (NCBI), based on which, primers were designed for each loci. Four pairs of robust and exclusive Umbel primers were recovered for four Umbel microsatellite loci. We also tested specificity of these primers, our result showed that there is one set of primers that we designed consistently amplify targeted species rather than close related ones. The data shows this primer can serve as a candidate microsatellite identifier for the detection of the Umbel. In conclusion we found one monomorphic microsatellite primer for the Huachuca Water Umbel, which can be used in future conservation efforts.

The Influence of Contaminants on the Optical Properties of a FeS₂, New Candidate for Large Area, Low Cost Photovoltaic Cells

Saxena, Aakanksha

Junior

Desert Mountain High School, Scottsdale, AZ

Teacher/Mentor: Dr. Nathan Newman

Solar power is a promising sustainable energy source. However, the key materials used in photovoltaic cells, the subunits of solar panels, are toxic, expensive, and highly defective. As a result, manufacturers have defect rates as high as 34.5%. Implementing alternative effective semiconducting photovoltaic options is essential for the survival of solar energy. If implemented in photovoltaic cells, FeS₂, the most abundant, low-cost, and non-toxic sulfide on Earth, would transform the solar industry: it has a suitable band gap energy level and acceptable absorption coefficients for solar panel usage.

However, production of FeS₂-based cells has been unsuccessful in the past. Conventional optical transmission measurements for measuring the band gap energy and contaminants have been unsuccessful because of its poor crystal quality. This makes it implausible to make accurate assessments of FeS₂ composition and use the material in cells.

This work overcomes this hurdle, using computer modeling and spectroscopy to demonstrate that reflection measurements can be performed to calculate the band gap energy and characterize the defect properties of contaminated FeS₂ in a novel, cost-effective fashion. Application of this research will allow for the production of high-quality, inexpensive FeS₂ -based solar panels that can transform the solar industry for decades to come.

Neuroblastoma: Exploring Novel Methods to Model Tumors and Improve Treatment Efficiency

Shah, Anuj
Junior

Hamilton High School, Chandler, AZ
Teacher/Mentor: Dr. Page Baluch

Neuroblastoma, an aggressive childhood tumor, often recurs due to the inability of chemotherapy to fully penetrate to the core of a tumor. Traditional methods of testing medications against cancer cell cultures do not address the three-dimensional structure of a tumor. In this experiment, realistic 3-D models of neuroblastoma were developed and tested against a combination of agents.

When 2-D cells cultures were exposed to chemotherapies, they were unprotected and thus showed high levels of cell death. The first 3-D model, created by overlaying cells on an agar monolayer, was inadequate, as cells were not very cohesive. The loose spheroids offered no protection or cell-to-cell tension, which led to easy chemotherapy penetration and high cell death.

A double layer of agar was utilized to create the next 3-D model, which more closely mimicked a tumor's characteristics. Cells formed more tightly packed clusters and as a result decreased drug penetration levels. Images revealed significant distance between areas of cell death and areas with live cells in the center of the model. The last 3-D model was developed using a rotary culture, which creates anti-gravity effects that cause cells to adhere to each other and form tumor with adequate cell-to-cell tension. Initial tests lacked cell growth, but future tests are expected to show limited penetration of chemotherapies, even with multistep treatments.

Accurate 3-D tumor models can be utilized to study other tumors with similar characteristics, as well as to test the efficacy of chemotherapeutic agents and agents that lyse outer dead cells.

Breatheasy: a Novel, Cloud-based Preventative

Health Care Solution Utilizing Machine Learning

Sidapara, Aditya

Sophomore

BASIS Scottsdale, Scottsdale, AZ

Teacher/Mentor: N/A

Breatheasy is a scalable, cloud based preventative health care solution. By integrating the public air quality API from the EPA and weather data, Breatheasy predicts heart rate variability recursively through client side API calls. Breatheasy uses a feed-forward network trained by the Resilient Propagation (rprop) algorithm, which extrapolates heart rate variability trends which are dependent on environmental factors, allowing for a more precise prediction. With both vertical and horizontal scalability and training algorithm's nature, its accuracy is dependent on the size of the dataset, which increases with every API call. Through numerous simulations, Breatheasy's accuracy stands at 91% with 3000 data entries, increasing at a slower rate with more entries. Its RESTful API allows for easy integration with existing software(s) and easy developer integration. Ultimately, more precise heart rate variability predictions play a critical role in foreshadowing asthmatic episodes¹, heart attacks², cancer³, and post-cancer fatigue episodes⁴.

Dual-Purpose Solar Water Heater and Electric Generation

Tallas, Nizhoni
Junior

Navajo Preparatory School, Farmington, NM
Teacher/Mentor: Yolanda Flores

Heat is harvested by transferring from the backing of a solar panel to copper tubing which has water flowing through at constant rate. The purpose of this research is to create a dual-purpose solar water heater and electric generation that can simultaneously produce hot water and generate electricity stored in a 12V rechargeable battery.

Water passed through the copper tubing was heated and when exited, the temperature of the water was noticeably hotter than the initial entry temperature. To make it purposeful, a rechargeable battery was simultaneously charged by the solar panel during the day. To make the overall solar panel reach its highest efficiency, the researcher made three light reflectors to give it a boost in gathering solar energy and heating water faster and hotter. Thus was tested at 5 minute intervals for 30 minutes for three trials to see how hot the water would get by going through the copper tubing. Electricity generated was also measured in volts.

Based on the results of the study, the dual solar panel was able to heat up water passing through the copper tubing as high as 26oC, the heating element heated the water as high as 80oC. The conclusion was accepted.

Cognitive and Brain Measures in Middle-Aged Autistic

Spectrum Disorder Individuals: Where are the Differences?

Wood, Emily

Junior

Xavier College Preparatory, Phoenix, ARIZONA

Teacher/Mentor: Dr. Brittany Blair Braden and Dr. Leslie Baxter

Introduction: As the aging ASD cohort becomes larger, there continues to be a paucity of research to assess their needs. This study is the beginning of one of the first longitudinal cognitive and brain studies in aging ASD. We hypothesized that the older ASD group would show change in brain structure and function that will match lower performance on frontal lobe-dependent cognitive measures.

Methods: We examined 16 ASD and 17 age-matched typically developing individuals from ages 40 to 65. All subjects completed cognitive testing. Structural MRI scans, diffusion tensor images, and Functional MRI were obtained. Working memory, fluency, and visual search tasks were obtained.

Results: Group analyses showed that the ASD cohort had thinner cortex in the frontal lobe and smaller volumes of the hippocampi, cerebellum white matter, and corpus callosum. The ASD group had decreased white matter integrity throughout the hippocampus, corpus callosum, and cerebellum, as well as greater frontal and parietal lobe activation during EF tasks and reduced resting-state DMN connectivity.

Conclusion: Our results supported our hypothesis that differences in older adults with ASD as measured by white and gray matter volumes, structural and functional connectivity, and cognitive data often center on the frontal lobe.

Phytochemical Analysis of Navajo Medicinal Plants

Yazzie, Leniah
Senior

Navajo Preparatory School, Farmington, NM
Teacher/Mentor: Yolanda G Flores

The purpose of this experiment is to analyze and find out what are the medicinal constituents present in traditional Navajo medicinal plants. - The hypothesis was, if I test traditional Navajo medicinal plants using phytochemical analysis and spectrophotometry, then tannins, terpenoids, flavonoids and saponins which are the medicinal constituents will be present to prove that these plants have medicinal properties.

To analyze the plants, phytochemical analysis was done to test for the presence of tannins, terpenoids, flavonoids and saponins. To further test the presence of these medicinal constituents, among those that are positive for those medicinal constituent test, spectrophotometry using a spectrophotometer was used. The Navajo medicinal plant tested were Big Sagebrush (*Artemisia tridentata*), Pinon Pine (*Pinus cembroides*), and Winged Buckwheat (*Eriogonum alatum*).

The hypothesis was accepted because using phytochemical analysis, all plants have certain medicinal constituents. Winged buckwheat had all four medicinal constituents, Big sagebrush had three (saponins, tannins and flavonoids) and pinon pine had two (terpenoids and tannins) positive for the medicinal constituents. Using spectrophotometry, winged buckwheat and big sagebrush tested positive for flavonoids.

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