Abstracts

Arizona Junior Science and Humanities Symposium

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ASU Polytechnic Campus, Mesa, AZ

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 2017 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   Laura Hobson
Arizona State University   Arizona State University

Population Dynamics in D. magna Exposed

to Minute Concentrations of Silica Gels

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Silica gels greatly impact D. magna populations, increasing the neonate and juvenile mortality rates by up to 6 and 1.5 times more. Silica is a common household good, found in toothpaste, packets and is easily accessible in large quantities. Without limitations on the usage and availability, it is almost certain these gels are impacting freshwater ecosystems where D. magna function as a keystone species.

Translational Genomics of Triple Negative Breast Cancer

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Background: Triple-negative breast cancers (TNBC) present an unresolved clinical dilemma. Many TNBC cases have BRCA1 or BRCA2 mutations which lead to homologous recombination deficiency (HRD). The striking resemblance of the CNV data between BRCA1 or BRCA2 mutant and BRCA1 or BRCA2 wild-type cases suggests that the HRD phenotype can result from genes other than BRCA1 or BRCA2. We investigated several key genetic alterations in DNA repair and chromatin remodeling proteins in TNBC patients in order to identify potential genetic alterations other than BRCA1 or BRCA2 mutations that would result in an HRD phenotype

Methods: Genetic alterations within TNBC patients (ages ranging from 45-83 years) were analyzed by whole exome sequencing (n=10), whole transcriptome RNA sequencing (n=9), and whole genome copy number variation (n=60). The sequencing data was mined for novel non-synonymous heterozygous genetic mutations. All genetic mutations were cross-referenced in the COSMIC database. Furthermore, an HRD score was given to each sample based on CNV data.

Results: We identified three patients "PAD758", "MEH783", and "BUT496" who were BRCA1 and BRCA2 wild type and had a high HRD score. Patient PAD758 harbored mutations in DCLRE1C and TET1 which were identified as potential sources of the HRD phenotype. For patient MEH783, a mutation in the gene PRKDC was identified as a potential source of the HRD phenotype. Patient BUT496 harbored mutations in the genes DTL and RIF1 which were identified as potential sources of the HRD phenotype.

Conclusions: Via whole exome sequencing, cases have been identified in which TNBC patients without BRCA1 or BRCA2 mutations have HRD phenotypes, presumably as a result of genes with related functions to the BRCA1 and BRCA2 genes such as DCLRE1C and PRKDC. HRD signature might serve as a critical predictive biomarker that will help stratify patients who will truly respond to PARP inhibitor therapy enabling doctors to avoid prescribing medication that is unlikely to be effective or that might cause serious side effects in certain patients, ultimately saving health care dollars.

Combating BEX2 Using Drug Discovery

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Brain-Expressed X-linked (BEX) family proteins comprise of five human intrinsically disordered proteins (IDPs) including BEX1, BEX2, BEX3, BEX4 and BEX5. These proteins have been linked to neuronal development and many studies also suggest that these proteins play a significant role in cancer. BEX2 is overexpressed in a group of breast cancer patients and also in gliomas and has been observed to be a promoter of cell proliferation.

The purpose of this project is to find viable small molecules that can target the BEX2 protein. Using past data on IDP and BEX proteins, CLUSTAL-W2 software, protein alignment and FunRich protein enrichment analysis, small molecule binding partners for BEX family proteins were found.

The Electrochemical Synthesis of Copper

Nanoparticles and Their Effect on E. coli.

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Experiments involving nanoparticles have typically been carried out in professional lab settings. The rationale of this project is to construct a nanoparticle synthesis method that can be performed in the average person's home using natural, household products. Copper was chosen as the base because it is known to rupture the bacterial membrane and form holes that drain vital nutrients and water. Ascorbic acid acts as both the complex agent and the stabilizer. All three levels of the main experiment's independent levels involve CuNP's constructed with ascorbic acid tablets, which range from 1 tablet to 2 then 3. The dependent variable would be the maximum absorption wavelengths of the nanoparticles. Then these CuNP solutions are also utilized to treat E. coli. The max. absorption wavelengths ranged from 397.4 nm to 441.6 nm. Generally, the trend for the ascorbic acid trials revealed an inverse relationship between reducing agent concentration and max. absorption wavelength peak. Also, with more reducing agent, the absorbance at the peak increased. The results demonstrated that the bacteria treated with one tablet were not visibly affected by the CuNP's, with an average of 26.25 colonies compared to the 24.67 colony average from the Controls. While for most of the two and three tablet trials, the bacteria in all except one trial died off. The hypothesis was supported in that as reducing agent concentration increases, NP wavelength and particle size decreases, increasing the surface-to-volume ratio that allows for more interaction and damage to the bacterial cells.

Utilizing Solar Technologies to Heat a Traditional Home

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On the Navajo Nation, families are faced with a constant struggle to heat their homes. Many heating technologies are costly or require significant manual labor to sustain. Fashioning a heating system to absorb solar radiation and combining it with a pump to circulate heated antifreeze into a home is an affordable way to heat a home without costly expenditures or continuous manual labor.

In this investigation, a solar heating system was built and installed on a traditional Navajo home or Hogan. The system transferred heat from antifreeze heated in the solar collector to a container of water. An Arduino microprocessor was programmed to measure the temperature of the water. The hypothesis, if a solar heating system is designed with copper tubing, metal fins, and heat reflective insulation and painted a flat black inside a sealed heating system then the solar heating system will produce temperatures above 18 degrees Celsius, was accepted. The highest temperature generated by the system was 21.44 degrees Celsius.

Compared to current heating methods this system would cost the same as one year's heating expenditures, but would last much longer. This heating system is ideal for people living in rural environments because it is self-sufficient and sustainable.

Native Bio-Plastic

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In this project, the researcher learned more about bio-plastic, and used this knowledge to create a version of bio-plastic using an important aspect of the Navajo culture, their corn. The researcher not only made a bio-plastic, but also set off to evaluate the plastic for use in 3D printing. To have a bench mark in order to be able to evaluate, and wanting to learn more about plastic, the researcher prepared and tested two other plastics, another bio-plastic (PLA) made commercially, and a traditional 3D printer plastic (ABS).

To collect the data, the researcher made the three plastic into filament for use of a 3D printer, and tested density ï•² (kg per unit volume), specific gravity ï•§ (density ï•² divided by the density of water), ultimate tensile stress ï•³ (breaking force divided by cross-sectional area), Youngs Modulus E, and its appearance.

In most of the test, the ABS plastic tested the best, with a high ultimate tensile stress ï•³ of 8.7 MPa and average melting point of 194 0C. This makes it perfect for 3d printing. ABS is followed closely by PLA with ultimate tensile stress of 2.1 MPa and melting point of 194 0C, Native Bio-Plastic was last, with a low melting point 190 0C low and a tensile stress 0.28 MPa.

In conclusion, the ABS plastic was the best performing plastic. The homemade Native bio-plastic, although being a bit weak, shows promise with having a reasonable melting point, and the highest density ï•² of the three plastics. With more practice at making and melting the plastic, the original goal of making an equal or better plastic out of Native corn appears to be a reasonable goal. Overall, the results show that the hypothesis was not accepted.

A Low-Cost, Clutter-Cancelling Life Detection System

for the Recovery of Victims after Natural Disasters

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Earthquakes are devastating natural disasters that affect areas all around the world. Many first-response teams face enormous struggle whilst recovering victims buried under destroyed infrastructure. Recognizing the main indicators of life include respiration and heart-beats, a system was designed last year that used a cheap module and filtering circuitry that was capable of detecting humans through 2 ft. of cinderblock wall, but failed when testing through more dense and thick materials. The largest problems with the previous system were the operating frequency and the presence of a signal called clutter, which is the portion of signal reflected from the frontal area of the barrier. A radar system was built from scratch that uses 2.7 GHz signal and a novel clutter-cancellation system to destructively interfere with background clutter. At the radar's output, Doppler signal travels through a series of filters and amplifiers and sampled with an analog to digital converter. Using a PCA and Fourier Transform the input was tested for presence of vital signal. The end radar was capable of detection through more material that last year's model, proving its field application. Currently, the radar is being fabricated on a PCB to reduce the footprint of the finalized system.

The Effect of β-hydroxybutyrate on histone deacetylase

activity and DNA damage repair within glioma stem cells

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The ketogenic diet (KD) targets abnormal metabolism in cancer cells by depriving the cells of their preferred energy source, glucose, while providing the body with an alternative energy source, ketones. Reduced glucose has long been thought to be the main therapeutic mechanism, but β-hydroxybutyrate (βHB), the primary ketone body produced while on the diet, has anti-tumor activity on its own. Thus βHB's impact on HDAC activity, and subsequently, DNA damage repair in GSCs and other glioma cell lines in vitro is being studied. Evidence has shown that HDAC activity is upregulated in many cancers, contributing to hypoacetylation of histones, altered DNA damage repair and increased radioresistance. Human glioma cancer stem cell lines (L0, L1 and L2) were analyzed for histone acetylation levels and DNA damage repair protein levels upon βHB supplementation. It was found that βHB inhibits HDAC activity in GSCs both with and without radiation treatment. It was also found that βHB lowers levels of DNA damage repair in GSCs due to the aforementioned increase in acetylation. These findings provide a better understanding of βHB's effect on radiosensitivity and the therapeutic potential of the ketogenic diet.

Comparing the Antibiotic Susceptibility of Probiotic Bacterium

Bacillus subtilis and Nature's Way Primadophilus Probiotic Capsules

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The aim of this study is to determine the antibiotic susceptibility of Bacillus subtilis--of which not much research has been conducted--and the commercial Primadophilus Probiotic Capsules which contains two species of Lactobacillus bacterium, acidophilus and rhamnosus. Part of the design is to also describe and compare the antibiotic susceptibility between a probiotic bacteria from a direct source (B. subtilis), and a commercially available product such as the Nature's Way capsules. The bacteria found in the capsule is meant to act as a control as there have been much more studies conducted on these species than Bacillus strains and thus, much more information is available on their function as an efficacious probiotic.

By conducting this experiment, the researchers hoped to produce new values which can shed light into the potential resistance these bacterium may have against the drugs Linezolid and Ampicillin. While a variety of antibiotic testing is available, the researchers used the Kirby Bauer Diffusion assay. Petri dishes with agar medium were prepared and then, under normal sterile conditions under a laminar flow hood, inoculated with bacteria. After inoculation, one antibiotic disk of Linezolid and Ampicillin were placed on each dish and the process was repeated for each bacteria. After labeling the dishes, they were left to incubate for approximately 24 hours at 34 degrees C. In both environments, the Ampicillin zones were not close to being twice as large as the Linezolid zones for B. subtilis. The mean diameter of the zones created by Linezolid on both bacterium were very close, meaning that Linezolid had the same affect on L. acidophilus/L. rhamnosus as it did on B. subtilis.

Academic Conformity Among AP Students

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Students are believed to readily conform to their teacher's knowledge; however, this statement is generalized. This research study analyzed this preconceived notion with Advanced Placement students in mind. Specifically, this study tested whether or not AP student relied on prior knowledge or conformed to teacher's knowledge when provided false information. The hypothesis for this experiment was that AP students would conform.

Through a quantitative analysis composed of two surveys, this hypothesis was tested. The first survey served as a preliminary test of the student's current knowledge. Then the teacher made three false remarks and one true remark (which served as the control group). After these statements, the same survey was administered again to determine if some students conformed to the teacher's knowledge.

This method revealed that the hypothesis was not fully supported. Thirty five percent of participants did not conform at all and another thirty two percent only conformed to one question. Based on this information, AP students do not blindly accept information that they are presented with; however, there is still a sense of conformity. Therefore, the prior generalization does not apply to Advanced Placement students to the same extent that it applies to other students.

Building Low-cost Prosthetics by SLAM

Scanning the Residual Limbs of Amputees

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Currently, there are more than 2 million amputees living in the U.S. alone and over 180,000 amputations are performed each year. There exists a huge need for prosthetics that are not only strong and durable, but also lightweight, aesthetically pleasing, and give the user dexterity. The purpose of this project was to build a low-cost system which can produce comfortable and functional prosthetics for amputees. A Microsoft Kinect was used to generate a 3-dimensional mesh which was healed and repaired. The mesh is then sent to a Java program in which potential pain points are identified. A prosthetist can then sculpt the mesh in the computer depending on whether they believe the pain point is valid. This mesh can then be sent to a Rapid Prototype machine, such as a 3D printer or CNC mill to be fabricated.

Identifying Pathways Enriched with

Differential Dependencies Using LASSO

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Recent advances in high-throughput transcriptomic profiling have given rise to several statistical methods for analyzing Gene Regulatory Networks (GRNs). More recently, the context-specificity of GRNs, mainly their topology, has garnered significant interest. Evaluation of Differential Dependency (EDDY) is one approach to analyzing these Differential Dependency Networks (DDNs), using Bayesian inference and network likelihood distributions to identify pathways enriched with differential dependency relationships. Bayesian inference, however, requires that expression data be quantized prior to analysis, leading to a possible loss of information. We propose an alternate approach for identifying differential dependency relationships based on using LASSO regression for GRN reconstruction. To assess differentiality, we cross-calculate Coefficients of Determinance and Normalized Error, and find the Hamming Distances between the GRNs. Statistical significance of uncovered differentiality is assessed asymptotically by approximating a null distribution via a beta distribution for which model parameters are estimated from initial permutations. In tests on data generated synthetically from models of increasing hamming distance, the metrics matched expected trends and we found high GRN inference accuracy. Additionally, we validated our approach to approximating significance of uncovered differentiality. Thus, we have successfully removed the quantization limitations of Bayesian EDDY and created a new network-level analysis of differential dependency.

A Novel Solution for the Visually RPi

Impaired Utilizing and Speaker-Rod Systems

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The most recent census showed there were 21.2 million Americans suffering from vision loss. Being visually impaired has many disadvantages, especially while traveling. One approach to help visually-impaired individuals is to provide visual information through a different sense. Most assistive devices on the market use ultrasonic and image-capturing sensors but do not have a set method of communicating this information to the user. Furthermore, these solutions are often obtrusive or cumbersome to use. Through this research, I have developed a potential solution.

A speaker-beam combination as a medium of tactile communication for visual information was investigated. A RPi (Raspberry Pi) was programmed to communicate information about the user's immediate environment obtained from the camera to illicit a specific frequency from the connected speaker. As a result, specific beams of a certain dimension and natural frequency will move in a certain pattern on the user's wrist. The efficacy of the wrist-mounted device will be measured.

Modifying and Applying the Kth Nearest Neighbor Algorithm

(kNN) to Enhance the Classification of Breast Cancer Tumors

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The kth nearest neighbor algorithm (kNN) is a non-parametric method used for classification, in which a query point is compared to a data set of points with predetermined classes. The nearest neighbors are determined through the smallest Euclidean distance from this query point; its classification is then discerned by the label that is most abundant among its neighbors.

This experiment sought to improve classification of breast cancer samples by modifying kNN. The standard kNN only classifies points based on distance, which could yield a high percentage error. This is because marginal points are incorrectly classified since outliers are given an equal weight to points more representative of their classes.

There were two themes of kNN modification: modifying how nearest neighbors were determined (Point Radius Method) as well as determining the confidence of neighbors (Gaussian Class Confidence Weights, Fuzzy Algorithm). The point-radius method achieved the highest percentage accuracy when k = 1. For both the Gaussian weighting scheme and Fuzzy Algorithm, error rates decreased as the number of nearest neighbors increased. The optimal range for neighbors, averaged across all modifications, was between k = 11 and k = 15.

Creating a Computational Model to in

Predict College Players' Success the NBA

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Every year, NBA draft picks are wasted on seemingly generational talent. Front office executives enamor the raw talent that some players exhibit and inaccurately evaluate their draft stock - many of these players never pan out. Some may argue that success in the NBA is unpredictable and that the spirit of the Draft Lottery reflects the draft itself. However, the past 10 years of draft classes have shown general trends that can be evaluated through computational algorithms in order to predict each player's value in the NBA. Win Shares are effective statistics for measuring success, as they are comprehensive scales that estimate the number of wins each player adds to their team. Building a crawler to scrape, college stats, measurements, and NBA win shares allowed for the construction of a multiple algorithms to maximize the accuracy of the model. Amongst Principal Component Analysis, TensorFlow, Multivariate Regression, and many other, an accurate model was created. If executives across the league were to adopt a similar framework, teams could not only maximize their own profits by developing prototypical teams, but could also give chances to previously under-evaluated talent, paving way for their successful careers.

Effect of Carboxylate Anion Glutamate Exposure

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Amyotrophic Lateral Sclerosis (ALS) is a progressive neurodegenerative disease affecting nerve cells and motor neurons, ultimately resulting in muscle atrophy and the degradation of motor functions. There are few methods for combatting ALS symptoms in humans; those available are highly experimental and not cost-efficient. An accessible and affordable treatment for combatting ALS symptoms in patients is reported in these findings. Recently, an overabundance of Glutamate, an essential amino acid and neurotransmitter, has been linked to ALS patients. Its aversive effects on overstimulation of motor neurons were induced and examined in C. Elegans through continuous exposure to Glutamic Acid (GLU) carboxylate anion. Over the course of a month, sufficient loss of motor functions were detected. Upon exposure to Docosahexaenoic Acid (DHA), neurogenesis of motor neurons was promoted along with Î²-oxidation in the endoplasmic reticulum.By one week, C. Elegans regained full motor function with continuous exposure to DHA. The highest concentrated environment of GLU experienced a 96% recovery from muscle atrophy symptoms.

Spinning Platonic Solids

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When spun, some shapes exhibit an interesting action. Shapes such as an egg or a tippe-top flips or rises from an initial stable point to an initially unstable point such as a vertex. To determine the relationship between facial surface area and if a shape will rise to a vertex when spun the following question was investigated: Does the surface area of one of the faces of a platonic solid effect if it will rise to a vertex when spun? It was hypothesized that that due to an increase in friction, shapes with a larger facial surface area would rise more often. The experiment was conducted by spinning all five platonic solids each of equal total surface area but of differing facial surface areas. The number of times the shape rose was measured out of 100 spins. Errors could have occurred during the experiment due to incorrect measurements, inconsistent spins, and/or false calculations. Further research could encompass the question: Does the angle between the shape and the table effect if it will rise?

The Influence of Stereotypes on Human Judgement

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The reason for this science fair project is to see how much stereotypes influence the judgement of humans. The hypothesis was males would have more people affected than females and the +25-age group of males would have the highest number of people affected.

20 people were gathered, 10 male and 10 female, and 10 ages 14-18 and 10 ages +25. A stereotype influence test was created and given to the test subjects and the tests were scored to determine how much of a percentage stereotypes influenced their judgement.

The males had more people affected than females with 2 people affected for the males and 1 person affected for the females. The 14-18 males had less people affected with no people being affected but the +25 males had 2 people affected.

The hypothesis was males would have more people affected than females and the +25 males would have more people affected than the 14-18 males. The results did support my hypothesis because the males had more people affected than the females with 2 people over the females' 1 person and the 14-18 males had no people affected but the +25 males had 2 people affected.

Improved Targeted Cancer Therapy: Combination Treatment

Of Polymer-Mediated Transgene Delivery And HDAC Inhibitors

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Polymer-Mediated Transgene Delivery is the process of introduced foreign genomic material--transfection--via polymer-DNA complexes (polyplexes) to a host cell to elicit a therapeutic benefit. Due to the versatility and biocompatibility of polymer vectors, this process demonstrates potential in serving as a superior alternative to traditional forms of therapy. Aminoglycoside antibiotic-derived polymers have been identified through prior research as effective vectors for transgene therapy. In addition, their lipid conjugates--lipopolymers--have also been investigated and established as viable vectors. Folic Acid (FA) attaches to Folate Receptors (FR), which are overexpressed in certain types of cancer cells. By utilizing FA into the structure of polymers, and as a result forming folate-conjugates, transfection efficacy may be further enhanced by allowing polyplexes to be recognized by FR. In order to enhance transgene expression, Histone Deacetylase (HDAC) Inhibitors (HDACi)--such as OG-L002, SB939, and 2-PCPA--are introduced to cells to silence HDAC enzyme activity and promote transcription. Polymer-Mediated Transgene Delivery and HDACi work in synergy to enhance transfection efficacy and transgene expression of the promising anticancer protein TRAIL-Tumor Necrosis Factor-Related Apoptosis-Inducing Ligand. This project investigates one aminoglycoside polymer, Neomycin resorcinol diglycidyl ether (NR); one lipopolymer, Neomycin glycerol diglycidyl ether-C18 (NG-C18); and one folate-conjugate polymer, NRFA; and their ability to work in synergy with a combination of HDACi--OG-L002, SB939, 2-PCPA, SB939+2-PCPA, and OG-L002+SB939--to enhance transfection efficacy of this process and improve transgene expression of TRAIL.

Developing a Comprehensive Bacteriophage Based Sanitation Chamber to

Remove Biofilms from Medical Devices in Clinically Relevant Settings

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Bacteriophages have been known to be capable of eliminating deadly bacterial infections, but their use on biofilms in medical settings has been very limited. In a prior investigation, bacteriophage solutions for elimination of Vibrio cholerae, Escherichia coli, Staphylococcus epidermidis, and Helicobacter pylori were identified. Targeted bacteria in the investigation were those commonly found in medical settings around the world. In the preliminary stage of the experiment, laser-generated shockwaves, ultrasound sonication, and UV-C treatment were tested on biofilms of the four clinically relevant bacteria. In the next stage, four different phages, KHP 30, T4, DP-1, and CTX-phi, were then added to the established biofilms, in conjunction with the newly proposed treatment techniques. The efficacy of the treatment was measured through counting colony-forming-units (CFUs) in the biofilm assays. The results displayed that a combination of the polyvalent bacteriophage mixture, UV-C radiation, ultrasound sonication, and the laser-generated shockwaves allowed for the inhibition of the number of CFUs formed, and in turn, most bacteria in the biofilm destroyed. This significance on curbing biofilm growth indicates the success of the treatments as a sanitation solution, as opposed to increasingly problematic chemical antibacterials and ineffective autoclave systems. The next stages of experimentation call for the final assembly of the prototype chamber and programming a comprehensive, micro-environment chamber for affordable, efficient, and effective sanitation in medical environments around the world.

Lingering Heavy Metal and Metalloid Toxins in the Allium cepa Root Tip and the

Bulb from Animas and San Juan Riverbeds, due to the 2015 Gold King Mine Spill

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The tentative research was to find potential heavy metal and metalloid toxins present in the Animas and San Juan riverbeds, due to the 2015 Gold King Mine Spill. There were tests on the mitotic index of the bulb of Allium cepa on both the Animas and San Juan rivers. The hypothesis states that if the Animas and San Juan Riverbed samples have medium to poor water quality, then samples will contain cellular aberrations, and a lower mitotic index in the Allium cepa root tip and bulbs.

Water and riverbed samples were collected one year and three months after the 2015 Gold King Mine Spill. Five green onions were planted in each river water and riverbed sample for one month. After one month, the onion root tips were prepared and observed using a digital microscope at 400X for the phases of mitosis as well as cellular aberrations. Non-dividing and dividing cells were counted to measure the mitotic index. These samples were compared to a control, a prepared slide of Allium cepa. Onion bulb exposed after a month and the riverbed samples were tested for metals using Oxford Geology Majors + Traces XRF.

The hypothesis was accepted; both Animas and San Juan riverbeds affected the mitotic index (0%) of the root tip with cellular aberrations such as elongated and had thicker cell walls. All of the onion bulbs in the XRF study had higher ppm concentrations of Zinc indicating cytotoxic effects on the mitotic index. The Animas Riverbed has higher weight percent of Aluminum, Calcium, and Iron oxides, which reduces the weight percent of common sand and has higher Lead, Arsenic, Zinc, Cobalt, and Nickel, while the San Juan Riverbed has a higher weight percentage of sand because it has less Aluminum, Calcium, and Iron oxides.

Quantitative Data Based Research on the Correlation Air of

Between Ambient Pollutants and the Health Human Societies

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In 2003, a satellite detected excessive amounts of methane gas flooding the Four Corners area which includes Native American reservations and four U.S. states. These satellites were from NASA's Jet Propulsion Laboratory and were first thought to be a mistake. This was the first detection of the Four Corners methane plume.

Particulate matter (PM) is a mixture of solid particles and liquid droplets found in the air. (EPA, web) Particulate matter 2.5 (PM 2.5) is fine inhalable particles that have a diameter typically 2.5 micrometers or smaller. (EPA, web) PM 2.5 is produced primarily from combustion including fireplaces, car engines and coal and natural gas fired power plants. (NRDC) In a study conducted by the World Health Organization's (WHO) International Agency for Research on Cancer (IARC) came to a conclusion which was "that outdoor air pollution is carcinogenic to humans, with the particulate matter component of air pollution most closely associated with increased cancer incidence, especially cancer of the lung." WHO IARC also states that "PM affects more people than any other pollutant." (World Health Organization, web)

Different geographic locations were investigated by data mining PM 2.5 levels in the time frame of 1999 to 2015. Contingency tables and frequency tables were developed and chi squared test of independence and Pearson Correlation Coefficient tests were conducted to determine whether the yearly level of PM 2.5 is correlated with the geographic region and the health of human societies in the area.

A Novel Approach to Prevent from

Damage Earthquakes and Tsunamis

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Today, increased tectonic plate activity in the Cascadia Megathrust Subduction Zone, located on the Pacific American Coast, has the potential to cause a massive earthquake with a magnitude upwards of 9.0 on the Richter scale and resulting tsunami that could cause severe architectural damage and large death tolls. Unfortunately, modern technologies used to reinforce buildings are not completely effective because they only absorb some shock in the foundation. Additionally, no current building design is completely resistant against the hydrostatic and buoyant forces from tsunamis. Therefore, it becomes necessary to design a cost-effective structure resistant to the effects of both of these natural disasters. After conducting research in civil engineering and physics at the Arizona State University and Oregon State University, a hexagonal model with a two-part base isolation system was designed and built utilizing neoprene rubber, alloy steels, and shock-absorbers. The model was tested against an earthquake simulation of the 2011 Japan Earthquake and multiple direct shear tests, and against various computer-controlled waves to measure the model's stability against hydrodynamic forces of tsunamis. Both tests had the model remain stabilized, thus supporting the potential of life-size structures along global coastlines to provide a safe-house during natural disasters.

Modification of Buildings Based on Termite Mounds

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The current way that the air conditioning of buildings is conducted is overly expensive and harmful to the environment. One potential solution lies in the deserts of Zimbabwe. Macrotermes, a genus of termites, produce mounds that thermoregulate independently. The Eastgate Centre, a building in Zimbabwe, was designed to imitate this process and function without modern AC. This research attempted to find a way to apply the same techniques to buildings that already exist. A scale model building with an added chimney and fans (similar to the Eastgate Centre) was compared to a similar model without modifications when exposed to a heat lamp, representative of the sun. The temperatures at each level of each building were recorded after being exposed to the light for five minutes. The differences in temperature between room temperature and the temperature after the light exposure were calculated and on average, the modified building resulted in a smaller difference than the control building. The mean was 4.2538 for the modified building and 5.075 for the control building. Although the difference between these statistics is small, the results prove that the design is promising and deserves further investigation, perhaps on a larger scale.

HemaDrop: A Novel Technique for Solid Blood

Microliter Analysis via Uniform Thin Solid Films

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Blood tests play an essential role in helping healthcare professionals monitor patient health, making them the highest-volume medical procedure. However, current blood analysis techniques necessitate a large volumes of liquid blood, which causes fatigue and fainting in normal patients and hospital-acquired anemia in critically ill patients. While liquid, small-volume analysis has not achieved satisfactory accuracy for implementation, solid blood analysis provides a promising alternative method for reducing blood volumes required for testing.

This study evaluates HemaDrop, a patented technique to create homogenous, thin, solid films (HTSFs) on hyper-hydrophilic surfaces using small drops of blood (5-10 microliters). However, a major concern inherent in solidifying blood plagues traditional solid blood analysis techniques. Blood can dry non-uniformly, increasing error, as not every spot would have identical composition.

Ion Beam Analysis (IBA) was performed on canine blood samples treated with HemaDrop to show film uniformity and thus viability for microliter blood analysis. Next, the qualitative properties of the films were observed using optical microscopy. IBA demonstrates that HTSFs created by HemaDrop are uniform. Optical comparison of blood and saline drops on HemaDrop-prepared films and untreated films via microscopy shows that drops on HemaDrop-treated samples were uniform, unlike those on untreated samples.

HemaDrop prepares uniform films to measure blood composition from microliter-volume drops. HemaDrop allows for analysis in vacuum, expanding the range of analysis techniques that can be applied for testing of patients using only drops of blood. By improving blood testing efficiency, this research could facilitate a fundamental change to blood analysis and thus could revolutionize patient care.

A One-Shot Machine Learning Framework for Diagnosis

Computer-Aided in Medical Images with Small Data Sets

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For decades, radiologists have been employed to analyze varying medical images for diagnosis and study. However, in recent years, researchers have built algorithms to conduct analysis on medical images automatically. These algorithms have varying applications such as Computer-Aided Diagnosis (CAD), content-based image retrieval, brain mapping, and image segmentation. This analysis has been done through machine learning. The problem arises when not enough images exist to train the medical imaging models. This situation becomes especially problematic when faced with an image with a new/rare disease or feature. Furthermore, it is rare for case studies to have an ample amount of data due to patient confidentiality and access. The experimental design is two-fold: One Convolutional Neural Network that utilizes Fine-Tuning and a One-Shot Learning Model. The one-shot Learning model employs mechanisms known as Transfer Learning and a Neural Turing Machine. It is built upon a recurrent neural network that accesses a memory matrix for long-term storage. These mechanisms create meta-learning for the network, enabling classification on small data sets. Tensorflow was implemented to deploy the model to achieve properly determine benign vs. malignant tumors for breast cancer images. Future research would include training varying types of cancer images to test robustness.

Musical Chemistry's Effect on Blood Pressure

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Music has been shown to be an effect treatment for cardiac patients, people with mental disorders and more yet there are discrepancies between the different studies done. This study aims to discover if music could be more consistent in its benefits if based off the chemical structure of chemicals required to achieve a desired effect. The information could contribute to the medical field and expand the knowledge of the science benefits of music therapy. Three songs were composed; two of which were composed based off the chemical structure of chemicals that naturally regulate a person's blood pressure. 50 human participants were asked to listen to the three songs and have their blood pressure taken before and after listening. The hypothesis is that if a person listens to the songs "Imperium", "Vasoconstriction", and "Vasodilation", then their blood pressure will change by either maintaining, increasing, or decreasing, respectively, as measured by the amount of change of the systolic or diastolic pressure afterwards. The experimental results do not support the hypothesis. Paired samples tests showed that for all three songs, there was not a significant change in blood pressure. For the most part, the initial and final blood pressure values remained about equal.

Exploring Novel Methods of Producing a Noncytotoxic to

EGFP-ATF6 Construct Signal Endoplasmic Reticulum Stress Response

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Osteosarcoma, a bone tumor of childhood, is lethal when unresponsive to chemotherapy. ER stress response, a cell survival mechanism that is triggered upon exposure to stressors such as chemotherapy, allows for this tumor chemoresistance. The transcription factor ATF6 is the most reliable biomarker of ER stress and translocates from ER to golgi to nucleus to induce unfolded protein response, resulting in chemoresistance. The development of future medications relies on the ability to assess movement of ATF6 from ER to golgi to nucleus.

The current mechanism of tracking ATF6 is to use fluorescent markers such as GFP, but the current EGFP-ATF6 plasmid is overexpressed and cytotoxic. This experiment seeks to modify the plasmid so that it can be effectively incorporated into an osteosarcoma cell line.

The first, most promising method to achieve this goal employs restriction enzymes to cut out the plasmid's enhancer, thereby preventing overexpression. The second utilizes primers to reconstruct the EGFP-ATF6 plasmid without the enhancer region. The third involves using an alternate vector for ATF6 with a weaker promoter.

An EGFP-ATF6 plasmid was created using the first method, and XL1-Blue competent cells were used to produce the plasmid DNA. The EGFP-ATF6 plasmid created in this experiment will be used to create a new stable cell line, to be used eventually in high throughput drug screening to search for agents that prevent ATF6 movement and UPR activation.

Exploring Unique Biological Processes of Angiogenic Tumor Progression using

Novel Differential Community Analysis and Machine Learning Survivorship Modeling

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Ovarian cancer is the 5th highest cause of cancer death among women in the United States, and 7th highest among the world [7]. Most ovarian cancer patients develop resistance to chemotherapy and ultimately, the cancer recurs [8], forcing greater research focus on tumor progression pathways, such as angiogenesis, the formation of blood vessels. In order to understand the angiogenic subtype, we modeled it through a gene regulatory network (GRN), which is a network that models interactions between genes. We propose a new method of determining genes and communities central to biological processes and survivorship using a two-tiered approach: differential community analysis for network significance and survivorship modeling for clinical significance. Differential community analysis is an adaptation of traditional community detection because it substitutes the random network model with a control network, comparing the underlying community structure between two networks. Using the network significant nodes in a GRN, we built a machine learning survivorship model using artificial neural networks that correlated survival with gene expression. We determined two differentially expressed communities in the angiogenic subtype, one which highlights the reactivation of numerous embryonic development processes that were never explored before and the second which represents the biochemical foundations of blood vessel formation. Ultimately, these computationally derived results suggest that embryonic development processes play a larger role than previously known and the suppression of their pathways are critical to effectively stop tumor progression and disease recurrence in ovarian cancer.

Thin-Panel, Cylinder-Arrayed, Solar Water Heater

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The purpose of this project is to build a Thin-Panel, Cylinder-Arrayed, Solar Water Heater that could heat water to the maximum temperature, use it for homes in rural areas. The hypothesis was If I create a Thin-Panel, Cylinder Arrayed, Solar Water Heater then I will be able to heat up water for general use. Soda cans were cut in half and placed copper tubing in the center to allow the sun's radiation to get reflected to the copper tubing therefore heating the water.

Testing was done for 55 minutes in 5 minute intervals. The solar water heater with mirrors and no Plexiglas was able to heat the water at very high temperature of 30.27 C in 20 minutes, a temperature difference of 12.27 C higher and heated water up to 562 Watts with an average flow rate of 10.96 g/sec. The solar heater with mirrors and covered with Plexiglas heated the water to a maximum of 35.57 C, a temperature difference of 17.6 C in 30 minutes and heated water to up to 775 Watts with an average flow rate of 10.53 g/sec.

 The hypothesis was accepted, the Thin-Panel, Cylinder-Arrayed, Solar Water Heater was able to heat up water.

The Effect of Ultraviolet Radiation on Protein Expression

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The purpose of this research project was dedicated to determining the ideal time frame of UV exposure that induces damage and increases expression of DNA repairing proteins, this was done by exposing samples for various times. Following the exposure, the proteins were harvested and run through a vertical polyacrylamide gel where proteins were separated by passing electricity through the gel and proteins were shown as bands. After staining, it was clear that the experimental groups had more proteins present than the control samples, and the samples exposed for the longest had the most bands present, which supports the hypothesis. These results would be used to make the induction of damage and protein expression more efficient so that the DNA repairing proteins can be harvested and used as a pharmaceutical due to the fact that many cancers are caused by damaged DNA within the body. Using these proteins as a pharmaceutical can help mend and reverse the damage done by the cancerous cells by repairing the DNA and ensuring that healthy, functioning cells are reproduced.

A Novel Haptic System to Overcome

Parkinsonian Freezing of Gait Events

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In the United States alone, as many as one million people live with Parkinson's disease every day. A majority of these patients further suffer from freezing of gait (FoG) events, which impair their movement in daily life and cause several serious injuries every year. In an effort to remedy this situation, this study has developed a wearable device that sends vibrations to the user, detecting steps and step lengths in an effort to correct abnormal gait or walking pace. Moreover, the device can send vibrations for the user to follow, increasing the user's attention towards their gait, and can set a specific walking pace for the user to follow. Through these gait modification tactics, this study hopes to correct and prevent FoG events and, by extension, prevent terrible injuries from occurring every year as a result of this disease.