Increased chemo-sensitivity to DNA-damaging agents conferred by the exercise myokine, irisin in breast cancer cells

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Breast cancer is a disease that affects 1 in 8 women. Epidemiological studies have shown that exercise is associated with a decreased risk of developing cancer, and improving prognosis of many cancer types, including breast cancer. Our studies demonstrate that irisin, a myokine produced by muscle cells upon exercise, increases the sensitivity of malignant p53 mutant MDA-MB231 breast cancer cells to the chemotherapeutic doxorubicin (dox) by over 90 fold. Irisin did not alter the dox sensitivity of malignant, p53 wild-type MCF7 breast cancer cells, or normal non-malignant MCF10A breast epithelial cells. Our studies will investigate the molecular mechanisms through which irisin sensitizes selected breast tumor cells to DNA damaging agents. Based on our data demonstrating that irisin induces chemo-sensitization only in the p53 mutant cells tested, we hypothesize that irisin sensitizes p53 mutant cells to DNA damaging chemotherapeutics by inhibiting cell cycle checkpoint genes, suggesting that irisin co-treatment may improve the effectiveness of current breast cancer therapeutics. Developing a dox/irisin combination therapy to achieve a significantly lower dox dosage would minimize the toxicities and side effects associated with DNA damaging chemotherapeutics. To identify the mechanism through which irisin is sensitizing cells, we are measuring proliferation, cytotoxicity, and apoptosis in the high throughput IncuCyte imaging system, in addition to metabolic endpoint assays. We will also assess the role of p53 mutations and downstream signaling pathways using knockdown and overexpression approaches. Our studies suggest that irisin may offer therapeutic benefits for breast cancer prevention and treatment.

Node Localization Using Transitional Region Based Distance Estimation

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With each passing year, all the appliances and devices around us are becoming “smarter”. The Internet of Things (IoT) is created when these devices communicate with each other. One of the key attributes of these smart devices is the ability to know their accurate location. While GPS and other hardware are currently being used for this purpose, cost and energy consumption are major limiting factors on their widespread adoption in the IoT space. Many different distance measurement techniques have been researched for localization, but there is still no perfect solution. In this research, a localization algorithm was proposed. The algorithm is based on transitional region based distance estimation. In a sender’s transitional region, the chance for a receiver to receive packets from a sender is reverse proportionate to the distance to the sender; the relationship between packet loss and distance is close to linear. For a network, all nodes estimate their distance to all their neighboring nodes. If some of the nodes know their accurate location as anchoring nodes, the accurate location information for every node can be estimated. The proposed algorithm is tested for 1-dimentional and 2-dimentional IoT deployments.

Dark Septate Fungal Endophytes

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Dark septate endophytes are a type of mycorrhizal fungi that colonize the roots of a variety of different plant species in a symbiotic relationship, Bouteloua Gracilis is a species of grass found growing throughout the U.S. It exhibits a close relationship with DSE and is found in abiotically stressful environments. DSE have been documented in ameliorating abiotic stresses to Blue Gramma, specifically concerning soil quality. Just as plant development is dependent upon soil Ph, DSE also have their own responses to soil acidity.

Lead Selenide Quantum Dots for Use in Solid-State Radiation Detectors

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The unique optical and electrical properties of lead selenide (PbSe) quantum dots (QDs); which are due to quantum confinement effects that are a product of their nanometer scale sizes, have made PbSe QDs an interesting material for various devices from solar cells to photodetectors. Here we aim to leverage another important property, the high Z number of the material, to fabricate solid-state radiation detectors for high energy waves such as x-rays and gamma-rays. PbSe QDs are prepared using colloidal synthesis techniques which employ a weakly binding oleylamine ligand as the stabilizing ligand, for the purpose of fabricating a solid-state radiation detector using PbSe QDs as both the blocking and detection layers. Using oleylamine rather than the more traditional strongly binding oleate ligand allows for the facile in-solution ligand exchange with shorter anionic ligands. QDs passivated with shorter ligands are then implemented into testing devices (such as FETs, capacitors, and simple photodetectors) by spin-coating the colloidal solution into films. Thicker films, which are necessary for attenuation of x-rays and gamma-rays, can be fabricated by using more concentrated solutions and slower spin speeds; without the need for additional layer-by-layer ligand exchange steps, which has hampered and prolonged the fabrication time of thick QD films in the past. Data collected from research devices, such as carrier mobility and carrier capacity, is then used to calculate the performance and assess the feasibility of PbSe QDs as a material for use in low-cost solution processed solid-state radiation detectors.

Key Words: colloidal synthesis, PbSe, quantum dots, radiation detection

PDF Malware Detection with Image Processing and Classification Techniques

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PDF (Portable Document Format) is a file format invented by Adobe for presenting, exchanging and archiving document that is independent of hardware, software, and operating systems. PDF file has a flexible structure that can embed different kinds of contents such as JavaScript code, encoded streams, and image objects etc., which can be exploited by cybercriminals to embed malicious code using tools like Metasploit. In this project, we propose a new method to detect PDF malware using image processing and classification techniques. The PDF files are first converted to images using byte plot or Markov plot. Then various image features are extracted from the images that can represent the distinct visual characteristics of PDF malware and legitimate PDF files. Finally, machine learning algorithms are employed to build the classification models to predict a new PDF file as benign or malicious. We evaluated the performance of the proposed method using Contagio PDF malware dataset. The results show that our method can achieve a 99.48% F1 score which is better than that of many popular antivirus scanners such as Symantec, Microsoft, nProtect etc. It is also shown that the proposed method is more robust to resist reverse mimicry attacks than the state-of-art machine learning-based method.

Keywords: PDF Malware, Image Processing, Image Features

Ultrasonics for High-Accuracy Low-Cost Flow Sensing Applications

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Flow measurement of corrosive liquids such as hot brine is difficult without expensive instrumentation. A low-cost ultrasonic flow sensor was designed and constructed from common plumbing hardware and commercially available ultrasonic transducers and electronics. A bench-scale study was performed to determine the applicability and limitations of the small-scale flow sensing device. Preliminary investigation suggests milliliter per minute resolution at a cost far below commercial solutions. Further study will include verification of flow rate range and resolution.

Understanding the distribution of rain and snow during Atmospheric River events: A case study of the 1861-62 event

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Atmospheric Rivers (AR) are narrow bands of water vapor transport, responsible for 90% of mid-latitude water transportation as well as intense and prolonged precipitation events. In the late 1861-1862 an AR event produced flooding that caused a magnitude of economic impacts. We hypothesize that precipitation from these events produces a change in the response of both high-altitude temperature sensitive trees and low-altitude precipitation sensitive trees and that these responses can be used to quantify this event. We created normalized growth indexes for each individual tree ring record and correlated the growth with factors such as altitude and species to quantify the growth. Analysis of the mapped tree growth response is used to extract a coherent signal that may be representative of AR events in general. This signal could then be used to determine if similar extreme AR events occur in earlier portions of the tree ring record. Analysis of this dataset will allow us to better understand, monitor and predict the impact of large AR events on California. The frequency and strength of AR events impacts the length of droughts, intensity of floods, ecosystem response and ultimately impacts on humans.

Subsurface hydrology of the Earth's largest sand dunes

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Understanding the subsurface hydrology, or ground water elevation, of arid environments like large dune forming deserts, is critical to sustaining habitable zones during times of rapid climate change. The tallest dunes and largest sand sea in the solar system is located on Earth, in China's Badain Jaran Desert. The Badain Jaran Desert provides a unique study area because it has been inhabited by human populations since prehistoric times, and provides a unique opportunity to utilize both geologic and archaeological evidence for indicators of Quaternary climate change over the past 5,000 years. We hypothesize that the decrease in water table elevation reflected in modern interdune lakes is a result of Quaternary climate change, transforming the region from wetlands to an arid dune complex. Although this area has a rich archaeological record, limited studies have been conducted to understand the modern water table elevation and its change through recent Earth history. Using satellite imagery and geospatial processing and analyzing tools such as ArcGIS and Google Earth, the modern ground water elevation was traced within the dune field and compared to ancient lake core sediment samples. The samples were radio-carbon dated to compare the rate of change in ground water elevation over the past 5,000 years. Utilizing the archaeological record within the study area, we compared the change in human populations within the region to the change in water resources over time and found a relationship between population decrease and a decrease in ground water elevation within the Quaternary.

Keywords: climate change, geology, archaeology, subsurface hydrology, dune complex

Effects of Geomorphology on Light Penetration in the Rio Grande

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Light penetration in aridland rivers, such as the Rio Grande, is restricted by parameters including turbidity, depth, and flow. Understanding the relationship among these parameters and light penetration will help provide a better understanding of habitat limitations for primary producers, such as algae; who are dependent on light to support photosynthesis. The purpose of my study is to examine the geomorphology of an aridland river and show the relationships among depth, turbidity, and light penetration to better understand the abiotic factors shaping the producer communities. Two sites were chosen along the Rio Grande in the Albuquerque reach along a gradient of turbidity. Velocity (m/s), depth (cm), light intensity (µmol), and turbidity (NTU) were collected along vertical transects through the water column that were 25 cm or greater in depth. Preliminary results show that changes in turbidity and water depth were significant statistically ($p < 0.05$) when predicting light penetration intensity with light availability decreasing exponentially at greater depths along the vertical column transect. By understanding the controls of light penetration in turbid waters, future studies can better delineate the limited environments for primary producers often constrained by the geomorphology of aridland rivers.

Keywords: Turbidity, light intensity, aridland rivers, geomorphology, abiotic factors, algae

The Relationships among Wind Speed, Precipitation and Temperature in New Mexico

Kenneth Hoke, Mesalands Community College

This study examined data from NOAA NCDC to find seasonal means for wind speed, precipitation and temperatures, and find correlations among the three variables. Automated Surface Observation Systems (ASOS) accumulated the data at 10-meter observation points from three different airports in the State of New Mexico (Clovis, Grants, and Carlsbad). I used long-term data sets to see if there have been variable changes, to include possibilities of precipitation shortages or abundances. The data sets occur during the period of January 2005 through January 2017. Findings show a pattern between wind speed, precipitation and temperature.
Results show the strong correlation between temperature variation and wind speed variation in reference to high and low pressure system changes as was suspected. I found no significant correlation between temperature change and precipitation. Only non-informative correlation between wind speed and precipitation was found in the high and low pressure system changes that precedes and during precipitation fall. I found no conclusive data to show that the precipitation had any direct effect on wind speed or vice versa. I compared these findings compared to studies conducted by Pryor et al., 2009. This study will be helpful in the future in predicting the wind speed and the future usage of renewable energies.

In Vivo Effects of Spherical and Star Shaped Gold Nanoparticles in Mice

Tristan Ortega, New Mexico Highlands University

Gold nanoparticles (AuNPs) have recently gained interest due to their many potential biomedical applications such as drug delivery. However, little is known about what shapes and sizes of AuNPs might be toxic *to animals*. This research assesses potential effects of star and spherical shaped nanoparticles in mice. When found in high concentrations, AuNPs may form intracellular aggregates, potentially destroying enzymes, proteins, and cellular functions. If aggregates form within the liver, kidneys, or heart, they may disrupt organ function and cause death. Based on preliminary studies showing a decrease in body weight in mice treated with spherical- shaped AuNPs, we hypothesized that *in vivo* spherical- shaped AuNPs are more toxic to mice than star-shaped nanoparticles. Varying amounts of AuNPs were injected into mice and toxicity was assessed. At the time of autopsy, microscopy was additionally used to qualitatively assess the shapes and sizes of visible aggregates of AuNPs. Our preliminary results indicate that at modest concentrations of AuNPs, lethality did not occur. The presence of aggregates was observed in some organs; largest aggregates were found in the liver. Future studies aim to assess potential liver toxicity of AuNPs by measuring blood levels of ALT.

Characterizing vibration frequency sensitivity and neural activity in escaping earthworms

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Escape responses are ubiquitous in the animal kingdom. There are over 6,000 known terrestrial earthworms, some of which have elaborate escape behaviors. In 2008, *Diplocardia mississippiensis* gained notoriety when multiple television crews reported on a southeastern traditional harvesting technique called "worm grunting". The leading theory for this behavior is predatory escape. Not all earthworms display this elaborate behavior, including *Lumbricus terrestris*, a species that is sold all over North America as live-bait; with reports of distribution of over 120 million worms annually from one company alone. It can be deduced that there are streams and lakes all over the continent with non-native *L. terrestris* colonies. The specific earthworm escape behavior of *D. mississippiensis* is well documented and studied. However, there has been very little research into the neurobiology underlying these behaviors. We are interested in characterizing and comparing vibration sensitivity induced neural activity and behavior of the different worm species. Ethogram scoring and electrophysiological recording techniques were used. We designed an apparatus that can expose unrestrained worms to a range of frequencies. We also designed an apparatus that isolates the anterior end of the worm to maintain a secure suction electrode placement for extra cellular recordings from the subpharyngeal ganglion. We introduced the same discrete frequencies that induced notable behavior events and recorded the accompanied neural activity. With these protocols in place, we can investigate multiple species and better understand how these introduced worms may react to predation in new environments.

Expression & Purification of SUMO Activating Enzyme 1 & 2 (SAE 1/SAE 2) for Viral Protein Interaction Studies

Jesse Dirmeyer, Western New Mexico University

SUMOylation is a post-transcriptional modification system that is essential to numerous cellular functions including DNA repair, cellular response to stress, and transcriptional regulation through the cell cycle. In recent studies, disruptions in the SUMOylation pathway have been shown to have a role in health ailments such as cancer and neurodegenerative disease. SUMO activating enzyme 1 and SUMO activating enzyme 2 (SAE1/SAE2) facilitates the binding of small ubiquitin-like modifier (SUMO) proteins to target proteins, which lead to the modification of their functions. SAE1/SAE2 activity is obstructed by the avian adenoviral protein, GAM1, resulting in the global inhibition of cellular SUMOylation. This study aims to determine the complex structure of the GAM1 and SAE1/SAE2, which would provide useful insight of their interaction and GAM1's role of SUMOylation regulation. For this study, SAE1 and SAE2 were cloned as a single peptide with flexible linker between them in previous studies. The conjugated construct was obtained and transformed into *E. coli* BL21 competent cells. Protein expression protocols were optimized to increase yield and solubility of both the recombinant proteins. Soluble protein was purified using affinity chromatography. A high yield of soluble pure complex will be used for functional and structural studies with purified GAM1 protein that will enhance our understanding of the mechanism behind virus-host protein-protein interaction and possibly revealing a target for anti-viral therapies.

Developing a Mental Model

Isaiah Liljestrand, New Mexico Tech

A mental model is a useful tool for describing user's general mental processes that go into certain actions. In this paper, we investigate how to enhance the usability of security applications by considering human factors. Specifically, we study how to better understand and develop the user's mental model in the context of computer security through the use of the reasoned action approach (RAA). RAA explains that a user's behavior is determined by her intention to perform the behavior and the intention is, in turn, a function of attitudes towards the behavior, perceived norms (or social pressure), and perceived behavior control (capacity and relevant skills/abilities). A user study was conducted to test the validity of each of the main components of the model. Our user study concluded that alterations to a computer security application improved by the analysis through the mental model created improved user behavior.

Plants in Space: Interactions between Morphology, Lignification, and Carbon Isotopic Composition

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Plants with the C_3 photosynthetic pathway rely on diffusion of CO_2 from the atmosphere to the chloroplast to capture carbon for growth and development. Leaf anatomy, cell wall thickness, causes resistance to CO_2 diffusion with the heavier stable isotope of CO_2 ($^{13}CO_2$) being slowed more than the lighter one ($^{12}CO_2$). In addition, the CO_2 capturing enzyme in photosynthesis, Rubisco, uses $^{12}CO_2$ faster than $^{13}CO_2$. The net result of these anatomical and enzyme effects is that C_3 plants capture more ^{12}C when the resistance to diffusion is low, when cell walls are thin. Lignin is the part of cell walls that gives them rigidity and increases strength for withstanding gravity and mechanical forces. Therefore, it can affect how much plants invest making thick walls. We are growing a C_3 species, *Arabidopsis thaliana*, with modifications to lignin content and photosynthesis, on the International Space Station (ISS) and Kennedy Space Center (KSC), in order to study how their growth and metabolism are affected under microgravity (space) versus Earth's gravity. We hypothesize that the plants grown in space will have thinner cell walls, which will decrease resistance to CO_2 diffusion and decrease the ratio of $^{13}C/^{12}C$ in plant tissues. Our preliminary data on *Arabidopsis thaliana*, grown on Earth, demonstrates that our method for visualizing plant anatomy and lignin content works with frozen tissues, like those we will receive from the ISS. We are currently using this method to confirm relationships between the $^{13}C/^{12}C$ ratio, leaf anatomy, and lignin content on Earth-grown plants.

Isolation, separation, and identification of antimicrobial compounds from *Ericameria nauseosa*

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Antibiotic resistance is one of the biggest public health challenges of our time. Plant extracts are potential new resources for identifying agents that could act as alternatives to traditional antibiotics in the treatment of antibiotic resistant bacteria. We have conducted a survey of the antimicrobial properties of twenty common plants of the southwest. Of the twenty plants analyzed, five yielded oils via steam distillation. Two of the five oils exhibit antimicrobial activity via Kirby-Bauer assay: *Vitex agnus-castus* and *Ericameria nauseosa*. The distillate of *E. nauseosa*, commonly called chamisa or rabbitbrush, was found to be the most active antimicrobial agent tested with activity against twelve of the thirteen bacteria tested. GC, TLC, and HPLC-MS have been used to separate and identify the components of the oil from *E. nauseosa*. A luminescent bioassay coupled to TLC is being explored for the identification of the active component.

Turbidity in the San Juan River and its association with arsenic and lead

Mariah S. Paul, Neilroy Singer, Perry H. Charley, Yoshira Ornelas Van Horne, Paloma Beamer, Jani Ingram, and Karletta Chief

On August 5th, 2015 the Gold King Mine Spill had accidently released contaminated waste water which contained arsenic and lead. The spill began in the Animas River, eventually affecting the San Juan River which lead to Lake Powell. The Navajo Nation uses the San Juan River for irrigation, livestock, and ceremonial purposes. Dr. Karletta Chief's research team collected water samples from March through August 2018 at five locations along the river. The research team measured conductivity, turbidity, temperature, total dissolved solids, and ph. The water samples were collected and acidified to a pH of <2 using nitric acid, they were then shipped to NAU, Northern Arizona University, for analysis. Using an ICP-MS machine the lead and arsenic were measured, arsenic ranged from 0.06 to 0.085 ppb, and lead ranged from 0.018 to 0.023 ppb.

While there is an association between turbidity and the concentration of arsenic and lead, it is not significant. Arsenic and lead concentrations were below the Navajo Nation EPA agricultural guidelines, 100 ppb and 5000 ppb, respectively. The Dine' community always prays for clean water on the reservation. To them, water is life, it is medicine and most of all precious. Seeking information and bringing results to the community brings the Navajo community hope for clean water for their health, animals, and most of all land.

Keywords: Water Quality, Arsenic, Lead, Inductively coupled plasma mass spectrometry (ICP-MS), Turbidity.

Spikerbox DIY

Levi Albert, Jason Lewis, Dr. Steve Cox, Dr. Ulises Ricoy, Northern New Mexico College

We are duplicating Backyard Brain's Spikerbox to further understand how it works, and how it can be used to educate the public about neuroscience. The Spikerbox takes neuron signals from a cockroach leg converts them into an audio signal and transmits them to a speaker, so the viewer can hear the neurons ticking as the leg is touched. This is to help understand the neurological connections within insects.

We are taking a pre-made instruction guide and building our circuit from spare parts laying around our engineering building. With help from our faculty and fellow Northern students, we can design and build our circuit, as well as being able to test it with a Spikerbox alongside to compare the output signals. Most of our components needed were on hand in our engineering build, others we had to order online. Being that we are both electromechanical engineering students, we were able to construct the circuit with relative ease.

As we are halfway through our project, it is not yet complete. We are expecting a fully operational Spikerbox duplicate by the end of the year. We will be able to take a leg of a cockroach and transmit the neuron signals from its leg to a speaker of ours. The design will be different, as we are building from scratch, so we will most likely design a box for it to be placed in.

Research Garden Experiments Reveal the Effects of Lineages in Pinyon Pine Growth and Performance

Dalyna Hannah, Navajo Tech

In 2016, in collaboration with Northern Arizona University, a research garden was developed in Navajo Technical University in Crownpoint, New Mexico to study the effects of climate change in the Southwest United States using a foundation species endemic to this region, Pinyon Pine, (Pinus edulis). Pinyons used for this study primarily came from two source origins: New Mexico portion of the Navajo Nation (NN) in Borrego Pass, Mariano Lake, Mariano Lake Pass (MLP), and Tsaile and Sunset Crater (SC) in Northern Arizona. Out of 402 seedlings originally planted in the garden, 163 survived and were measured for height, trunk diameter, total shoot growth, and distribution of shoot type (between bract and fascicle shoots) to determine the effects of lineages on pinyon growth and performance. We found that overall NN seedlings outperformed their SC cohorts except on seedling height and bract shoot percentage and MLP seedlings from NN performed better than its NN cohorts. However, similar growth patterns were found between SC seedlings and Borrego Pass seedlings suggesting limited adaptive responses which indicate their possible suitability for use in restoration efforts across diverse habitats over other sources and lineages with less adaptive potential. Integrating belowground measurements with aboveground measurements is recommended in future studies to distinguish which type of response (adaptation, phenotypic plasticity) was/were elicited.