27TH ANNUAL

MARCH 29, 2022

# RESEARCH DAY AT THE CAPITOL

*Recognizing Exceptional Oklahoma Undergraduate Research*

OK NSF EPSCoR is funded through National Science Foundation Grant No. OIA-1946093 & Oklahoma State Regents for Higher Education.

# 27TH ANNUAL
# *Research Day at the Capitol*

TUESDAY, MARCH 29, 2022 * STATE CAPITOL OF OKLAHOMA * OKLAHOMA CITY, OK

## AGENDA

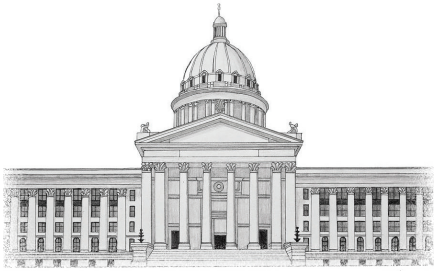
### CAPITOL POSTER PRESENTATIONS & AWARDS CEREMONY

| | |
|---|---|
| **7:30 a.m.** | **Student Researchers Check In**<br>(*State Capitol, Rotunda, 2nd Floor*) |
| **8:30 a.m. - 11:15 a.m.** | **Scientific Posters on Exhibit**<br>(*State Capitol, Rotunda, 2nd Floor*) |
| **11:30 a.m.** | **Awards Ceremony**<br>(*State Capitol, MultiPurpose Room 100, 1st Floor*)<br>Dr. Kevin Wagner, OK NSF EPSCoR Project Director<br>Dr. Raman P. Singh, OK EPSCoR State Director<br>Dr. Allison D. Garrett, Chancellor of Higher Education |
| **Noon** | **Adjourn** |

*Special thanks to our esteemed poster competition judges:*

*Jennifer Chain, OBI; Jason Lewis, USGS; Sherry Marshall, Science Museum Oklahoma; & Brian O'Dell, FLIR Systems*

Event Sponsors:



# 27th Annual
# *Research Day at the Capitol*

## Student Participant List & Poster Guide

| # | Student Researcher | University Represented | Research Topic | Hometown |
|---|---|---|---|---|
| 1 | Ms. Carys L. Delaplane | Northwestern Oklahoma State University | Adolescent Postpartum Depression | Enid |
| 2 | Ms. Hallum C. Ewbank | University of Central Oklahoma | Ecological Damage, Toxicology | Edmond |
| 3 | Ms. Camille M. Goerend | Southwestern Oklahoma State University | Antibacterial Target | Weatherford |
| 4 | Ms. Amy R. Killmer | College of the Muscogee Nation | River Erosion | Weleetka |
| 5 | Ms. She'Kayla Love | Cameron University | Photometric Study | Lawton |
| 6 | Mr. Jacob C. Mantooth | East Central University | Artificial Intelligence | Lindsay |
| 7 | Ms. Lydia Ostmo | Northeastern State University | DNA Replication | Tulsa |
| 8 | Ms. Mackenzie Powell | Southeastern Oklahoma State University | Nutrition | Madill |
| 9 | Mr. Bryce Sanchez | Rogers State University | Nicotine Effects | Collinsville |
| 10 | Mr. Brody Stroup | Rose State College | Photoelectric Effect | Norman |
| 11 | Mr. Joseph Ummel | University of Science & Arts of Oklahoma | Computational Chemistry | Blanchard |
| 12 | Mr. Alex X. Arreola | Oklahoma State University | Discovering Fungi | Coweta |
| 13 | Ms. Alisha Asif | OU Health Sciences Center | Cancer | Edmond |
| 14 | Mr. Rio B. Bonham | Oklahoma State University | Irrigation Management, Sensors | Tishomingo |
| 15 | Mr. Noah G. Bridges | University of Oklahoma | Businesses' Financial Outlook | Norman |
| 16 | Ms. Cody B. Cummins | Oklahoma State University | Tactical Wellness | Oklahoma City |
| 17 | Ms. Ann Marie E. Flusche | The University of Tulsa | Cancer Metabolism | Tulsa |
| 18 | Ms. Lydia Hashemi | University of Oklahoma | HPV-Induced Cancer & Fruit Flies | Tulsa |
| 19 | Ms. Allison P. Hussin | The University of Tulsa | 3D-Printed Electrochemistry | Bixby |
| 20 | Ms. Mahaalakshmi Narayanan | University of Oklahoma | Wildfires & Transmission Towers/Lines | Broken Arrow |
| 21 | Ms. Lauren Nguyen | University of Oklahoma | Antibiotic Resistance | Oklahoma City |
| 22 | Mr. Daniel R. Reed | Oklahoma State University | Antimicrobials, Microbiology | Sapulpa |

**Poster #1**

**Student Name:** Carys L. Delaplane
**Research Topic:** Adolescent Postpartum Depression
**University:** Northwestern Oklahoma State University
**Hometown:** Enid

**Researcher(s):** Carys L. Delaplane, M. Montgomery and A. Lujan
Charles Morton Share Trust Division of Nursing
Northwestern Oklahoma State University, Alva, OK
**Faculty Advisor:** Dr. Leslie Collins, Northwestern Oklahoma State University, Alva, OK

## REDUCING THE DIAGNOSIS OF POSTPARTUM DEPRESSION IN ADOLESCENT MOTHERS

Postpartum depression is characterized by the symptoms of severe depression and irritable moods from one day to 12 months after the birth of an infant. Adolescent mothers are at an increased risk for postpartum depression compared to their adult counterparts due to their developmental changes, lack of a stable support system, low socioeconomic status, and lack of education. Adolescent mothers often do not realize that they are experiencing feelings of depression as they are closely related to the expected outcomes of becoming a mother. Maternal postpartum depression is linked to difficulty transitioning into a motherhood role and difficulty meeting the infant's needs. This evidenced based practice project examined multiple studies with different interventions to determine ways that health care workers can implement to help prevent the diagnosis of postpartum depression in these vulnerable mothers. These studies show that by providing individual patient care based on the adolescent mother's risk factors and needs, health care workers can help prevent a diagnosis of postpartum depression. Health care professionals need to be educated on screening adolescent mothers for their risk factors for postpartum depression, signs of depression, and the mother's views of postpartum depression. By talking to the adolescent mothers, health care professionals can help decrease the stigma behind depression as well as provide education, early screening, and individualized care to prevent the diagnosis of postpartum depression. Health care workers should also be aware of the resources within their community that these mothers can be referred to for help outside of the health care setting. In the state of Oklahoma, one in six mothers are adolescents, giving the state the 4th highest adolescent birth rate in the United States, as of 2019. With Oklahoma's high adolescent birth rate, health care workers should be educated and given access to resources to help serve these mothers by protecting them from developing postpartum depression. By preventing postpartum depression, the adolescent mothers will be able to better bond and care for their baby, which will cause both the mother and the baby to be healthier.

**Poster #2**

**Student Name:** Hallum C. Ewbank
**Research Topic:** Ecological Damage, Toxicology
**University:** University of Central Oklahoma
**Hometown:** Edmond

**Researcher(s):** Hallum Ewbank, Y. Pagan and C. Goodchild
Dept. of Biology
University of Central Oklahoma, Edmond, OK
**Faculty Advisor:** Dr. Christopher Goodchild, University of Central Oklahoma, Edmond, OK

# THE CARDIOTOXIC EFFECTS OF MULTIPLE POLYCYCLIC AROMATIC HYDROCARBONS IN DEVELOPING CHICKEN EMBRYOS

Polycyclic aromatic hydrocarbons (PAHs) from oil spills are highly toxic to birds and can cause death and other sublethal pathological conditions. Additionally, previous studies in other organisms (e.g., fish) have found embryonic exposure to PAHs causes embryotoxicity and interferes with cardiovascular development. However, the embryotoxicity of *in ovo* exposure to PAHs has been less well studied in avian embryos. Previous studies explored lethal doses of certain PAHs and sublethal effects of whole crude oil on avian embryos, but more investigation is necessary to determine sublethal effects of individual PAHs. This study aims to find the impact of sublethal *in ovo* exposure of six PAHs (anthracene, phenanthrene, pyrene, benzo[a]pyrene, chrysene, fluoranthene) on avian embryonic heart rate and development. To do so, we monitored heart rate of developing chicken embryos at days 10, 14, and 18 after injection with five different concentrations of each PAH tested. On day 18, we collected morphometric variables and organ mass (brain, liver, heart). Additionally, we collected heart tissue to measure mRNA expression of pro-inflammatory cytokines and antioxidant enzymes to better understand the mechanism for cardiac damage. We found evidence of decreased heart rate in chicks exposed to benzo[a]pyrene, chrysene, phenanthrene, and pyrene and we observed increases and decreases in the heart rate of chicks exposed to fluoranthene. Additionally, we observed an increase in heart mass of chicks exposed to phenanthrene and chrysene and an increase in liver mass of chicks exposed to low doses of anthracene, benzo[a]pyrene, chrysene, and fluoranthene. These results indicate potential embryotoxicity from exposure to all six PAHs tested and potential cardiovascular damage from exposure to benzo[a]pyrene, chrysene, phenanthrene, pyrene, and fluoranthene. Developmental effects from *in ovo* exposure to PAHs could have long-lasting effects for post-hatch survival and fitness, especially if impaired cardiac function impairs ability to fly long distances.

**Poster #3**

**Student Name:** Camille M. Goerend
**Research Topic:** Antibacterial Target
**University:** Southwestern Oklahoma State University
**Hometown:** Weatherford

**Researcher(s):** Camille M. Goerend, L. Thomas, R. Rajan and V. Somalinga
Dept. of Biological Sciences
Southwestern Oklahoma State University, Weatherford, OK
**Faculty Advisor:** Dr. Vijay Somalinga, Southwestern Oklahoma State University, Weatherford, OK

## β-CARBONIC ANHYDRASE – A POTENTIAL NOVEL ANTIBACTERIAL TARGET AGAINST *RHODOCOCCUS equi* THE CAUSATIVE AGENT OF PNEUMONIA IN FOALS

*Rhodococcus equi* is a soil dwelling bacteria that causes mucopurulent pneumonia in foals. Transmitted through inhalation or ingestion of contaminated soil, *R. equi* pneumonia is hard to detect initially with subsequent progression to critical infection. Once well-established in the host, *R. equi* pneumonia is hard to treat with 20% of the infected foals dying from the infection. Although current treatment procedures result in positive prognosis, the success of the treatment relies on early detection of infection and good farm management practices. In addition, emergence of antibiotic resistance in *R. equi* has also been reported recently complicating the treatment process. The endemic nature of this infection in equine farms, difficulty in treatment procedures combined with the emergence of antibiotic resistance in *R. equi* has necessitated the search for new treatment options. Recently, in *Mycobacterium tuberculosis*, a close relative of *R. equi*, studies have shown that inhibition of β-carbonic anhydrase (β-CA) activity leads to impaired growth and decreased virulence. These studies have established Mycobacterial β-CA as a potential novel antimicrobial target which prompted us to search for the presence of β-CA in *R. equi* genome using computational analysis. Our search retrieved a β-CA from *R. equi* with high sequence similarity to a well characterized *M. tuberculosis* β-CA, Rv3588c. Further computational analysis of the *R. equi* β-CA homolog, hereafter called ReqCanB2, revealed extensive structural and active site homology to other well-studied β-CA's which lead to hypothesize that ReqCanB2 is a β-CA homolog in *R.equi* and capable of reversible $CO_2$ hydration activity. To prove that ReqCanB2 is indeed a β-CA, the gene was cloned, over-expressed, and purified using standard techniques. CA activity assay revealed that ReqCanB2 is indeed a CA with typical $CO_2$ hydration activity. The crystal structure of ReqCanB2 was determined in its native form which revealed a tetrameric arrangement and zinc ion coordinated active site typical of β-CA's. Currently, we are continuing further structural and biochemical analysis of ReqCanB2 to fully characterize this protein with the goal of identifying inhibitors that can be used to treat *R. equi* infections.

**Poster #4**

**Student Name:** Amy R. Killmer
**Research Topic:** River Erosion
**University:** College of the Muscogee Nation
**Hometown:** Weleetka

**Researcher(s):** Amy R. Killmer
Dept. of Natural Resources and General Education
College of the Muscogee Nation, Okmulgee, OK
**Faculty Advisor:** Instr. Cynthia Sanders, College of the Muscogee Nation, Okmulgee, OK

# EROSION OF AGRICULTURAL DEVELOPED RIPARIAN

**Introduction:** Erosion can impact aquatic environments. Sedimentation deposition can lead to pollution distribution. It degrades the land, increasing the chances of mass wasting and flooding. Agricultural areas are especially susceptible with nutrient loss and pollution with sediment attrition. It predicted that additional soil weathering could lead to land loss. Reducing land mass loss is essential for rivers and can be initiated with riparian land management practices.

**Materials and Methods:** The methods used for this study included river flow discharge monitoring. The surface area of soil wedging, TSS, GIS data, and site pictures determined land loss. Water quality testing determined pollution and nutrient concentration.

**Result:** Water quality analyses were conducted and compared to alluvial sources in Okmulgee and Hughes County, associated with the North Canadian River. Sediment-associated pollutants lacked elevated levels, and the ph level was 8.5 and may be influenced by the alkaline soil near the river. Turbidity and total dissolved soils are significant for both sites, and the comparison sites have differences in ph. The evaluation of the landmass indicates that faults inland appear to be 3.28 meters in length, and this fault has reached the riparian edge and appears to be weakening.

**Conclusion:** Results predicted that some more cracking would lead to land loss. While a landmass loss is evident, the level of soil disintegration is occurring slowly. The riparian bank is getting weaker; it brings up safety concerns during the evaluation. Rehabilitation of the eroding bank could help with future landmass loss. Reconfiguring the bank with strong rooted plants could help with landmass loss. Root support could be beneficial to the soil. In the spring of 2022, Ryegrass, Bermuda grass, two Hybrid Poplar trees, as well as common reed rhizomes will be planted. These plants are all native to the area.

**Relevance of Study:** In summer 2021, the landowner of the North Canadian agricultural site noticed a significant change when a field of alfalfa no longer had an access road. Near the river, a landmass had fallen into the river and appeared to be caused by erosion. The river had reached its banks but had not flooded. Such concerns with agricultural use property are both environmental and economic. For the researcher conducting the study, evaluating the area for erosion risks was important because she was one of the property owners affected by the regional changes.

**Poster #5**

**Student Name:** She'Kayla Love
**Research Topic:** Photometric Study
**University:** Cameron University
**Hometown:** Lawton

**Researcher(s):** She'Kayla Love[1], S. Hazra[2] and M. Fitzgerald[3]
Dept. of Chemistry, Physics, and Engineering, Cameron University, Lawton, OK[1,2]; Edith Cowan Institute for Education Research, School of Education, Edith Cowan University, Joondalup, WA, Australia[3]
**Faculty Advisor:** Dr. Susmita Hazra, Cameron University, Lawton, OK

## PHOTOMETRIC STUDY OF RR LYRAE STAR TV LYN

In this research, we are reporting the light curve of RR Lyrae type variable star TV Lyn. This star is observed in the northern hemisphere and its coordinates are 07:33:31.7 +47:48:09.8. We have used data from Las Cumbres Observatory (LCO) which consists of a worldwide network of robotic telescopes. Photometric measurements were conducted using the SBIG 6303 0.4-meter telescope with a field of view of 29' x19'. Depending on what the color of a star is when different filters are applied to it, the luminosity will change accordingly. Our data consists of four filters, Bessell B (Blue), Bessell V (visual), SDSS-I (Infrared), and PAN-STARRS-Z (Near Infrared). Results show that this star has a variability period of 0.2407±0.002 days, metallicity -1.49, and located at a distance of 1362±118 *pc*. We have used estimate of the reddening E(B-V) = 0.08. This research is a part an Our Solar Sibling Project by an undergraduate student with the help of a faculty advisor and an Our Solar Project Investigator.

**Poster #6**

**Student Name:** Jacob C. Mantooth
**Research Topic:** Artificial Intelligence
**University:** East Central University
**Hometown:** Lindsay

**Researcher(s):** Jacob C. Mantooth
Dept. of Mathematics and Computer Science
East Central University, Ada, OK
**Faculty Advisor:** Prof. Nicholas Jacob, East Central University, Ada, OK

# MATHEMATICS OF DEEP LEARNING

Deep learning is a highly complex mathematical process of probability and model building. In this research, we utilize the handwritten digits from the MNIST dataset. We examine the mathematics of deep learning by building a simple model in the deep learning style. To develop this deeper understanding, we look at the interplay of linear algebra and non-linear ReLU or ramp function. We further explore the creation of a deep learning model using the logical XOR function in an attempt to design all features of the model. We also explore the PCA dimensional reduction, linear regression and how these work when interchanged. Using python, Jupyter notebooks, TensorFlow, numpy, pandas and ORU's Titan super-computer, we are able to create models of deep learning to examine the mathematical tools utilized. We are able to create models in each circumstance examined with varying accuracy. We provide a proof on the interactions of the PCA and linear regression and show the difficulty of using small datasets in deep learning. The understanding of mathematics in deep learning is essential to programming models. We are able to combine linear algebra, probability, statistics, and calculus to create these models. Training computers to recognize images is of great importance for the development of AI, self-driving vehicles, satellite imagery, and surveillance. With the abundance of applications and the AI being used in our homes and daily lives, it is important to reflect that this is just a mathematical process.

**Poster #7**

**Student Name:** Lydia Ostmo
**Research Topic:** DNA Replication
**University:** Northeastern State University
**Hometown:** Tulsa

**Researcher(s):** Lydia Ostmo and S. Das-Bradoo
Dept. of Natural Sciences
Northeastern State University, Broken Arrow, OK
**Faculty Advisor:** Dr. Sapna Das-Bradoo, Northeastern State University, Broken Arrow, OK

# MCM10 AND POLε INTERACTION REVEALS POTENTIAL FOR UNDERSTANDING CANCER AND FILS SYNDROME

DNA replication requires many proteins to interact together to keep copies of our DNA intact and free of errors because mistakes or breakages in DNA can lead to diseases like cancer.

Our laboratory is interested in two of the many proteins involved in DNA replication; DNA Polymerase Epsilon (Polε) and Minichromosome maintenance protein 10 (Mcm10). These proteins are highly conserved from yeast to humans.

Our laboratory has found evidence that the catalytic subunit of Polε, called Pol2 in budding yeast, interacts strongly with Mcm10, and this interaction in yeast is required for proper error-free DNA replication process. Additionally, mutations in POLE1 (the human homolog of Pol2 in budding yeast) have been associated with different types of cancer and with a rare disease called FILS syndrome in humans.

We are interested in these disease-causing mutations and so created the specific mutations in yeast Pol2 using the CRISPR-Cas9 genome editing technique. We observed that some of the tested Pol2 mutations disrupted interaction with Mcm10 and delayed chromosome replication when cells were subjected to DNA damage. Our results in yeast suggest that specific Pol2 mutations, unable to bind Mcm10, have difficulty overcoming DNA damage and restarting replication.

We have expanded our work from yeast to human cells, specifically HEK293T (Human Embryonic Kidney) cells. Co-immunoprecipitation experiments confirmed that the catalytic subunit of Polε in humans, POLE1, and MCM10 also interact in human cells. This observation is similar to our results in yeast. Next, we constructed mutations in human POLE1 that are present in cancer and FILS syndrome patients. Our recent results with the mutants have shed light on the functioning of Polε in cancer and FILS syndrome patients.

**Poster #8**

**Student Name:** Mackenzie Powell
**Research Topic:** Nutrition
**University:** Southeastern Oklahoma State University
**Hometown:** Madill

**Researcher(s):** Mackenzie Powell, S. Fletcher, C. McKinney, A. Eleazar Rubio and N. Paiva
Dept. of Chemistry, Computer, and Physical Sciences
Southeastern Oklahoma State University, Durant, OK
**Faculty Advisor:** Dr. Nancy Paiva, Southeastern Oklahoma State University, Durant, OK

# ANALYSIS OF ANTI-NUTRITIONAL FACTORS OF REDBUD USING *MANDUCA sexta*

**Introduction:** We are comparing the growth of Tobacco Hornworms (*Manduca sexta*) on media supplemented with cooked and uncooked ground seeds of redbud (*Cercis canadensis*), both mature and immature (green), and mature kidney beans. Indigenous people reportedly consumed green redbud seeds after roasting. Many uncooked legume seeds such as kidney beans are toxic to humans.

**Methods:** Powdered cooked and uncooked seeds from mature redbud seeds, immature redbud seeds, and kidney beans were mixed into basal media in 1/5 proportion. After mixing the ingredients, each worm was placed with the same amount of medium in its own cup. When the first worms ran out of food, all worms were weighed.

**Results:** Average weights for worms receiving 20%(w/w) uncooked green redbud seed diets were reduced by 20 to 87%, while those receiving mature seed powder were reduced by 51 to 93%; experiments begun with smaller worms had much larger percent growth inhibitions than those begun with larger worms. Cooking green seed paste at 100ºC for over 30 minutes greatly improved the growth of worms to near control levels. Cooking mature seed powder improved worm growth, but usually not to control levels.

**Conclusion:** Addition of either uncooked green (immature) redbud and uncooked mature redbud seed powder inhibited the growth of young hornworms, suggesting they are toxic. The worms grew better in media containing cooked green redbud seed powder, suggesting that cooking immature seeds before eating them may have reduced toxicity to humans. The raw and cooked kidney bean powder had little impact on worm growth.

**Relevance of study:** Potentially one could identify the anti-nutritional factor in the redbud seeds that the worms do not like or are inhibited by and make an all-natural pesticide or repellent to increase crop yields.

**Funding:** This project was supported by the National Institute of General Medical Sciences of the National Institutes of Health under award P20GM103447.

**Poster #9**

**Student Name:** **Bryce Sanchez**
**Research Topic:** **Nicotine Effects**
**University:** **Rogers State University**
**Hometown:** **Collinsville**

**Researcher(s):** **Bryce Sanchez**
**Dept. of Biology**
**Rogers State University, Claremore, OK**
**Faculty Advisor:** **Dr. Jin Seo, Rogers State University, Claremore, OK**

# THE EFFECTS OF NICOTINE AND E-CIGARETTE JUICE ON THE DEVELOPMENT AND LIFESPAN IN *DROSOPHILA melanogaster*

**Introduction:** As of 2020, there are a reported 8.1 million users of electronic cigarettes among the U.S. population, ranging from people that previously smoked tobacco cigarettes to teenagers and pregnant women. Although e-cigarettes may seem less harmful than tobacco cigarettes, there is little research on how e-cigarettes will affect the development of offspring during pregnancy. In our experiment, we exposed mated fruit flies to differing concentrations of nicotinic e-cigarette juice and analyzed development (weight, fat content) of the offspring. We hypothesized that higher nicotine concentrations would lead to a decrease in both development and lifetime in the flies.

**Aims:** According to certain researchers and health professionals, “You can use your e-cigarette as often as you need to stay smoke free…” (while pregnant), as long as they don’t contain tobacco. Due to these claims, we wanted to test if the nicotine content mothers were ingesting during pregnancy had a negative effect on their offspring.

**Methods:** We placed white-eye fruit flies ($W^{1118}$) into 3 separate vials containing differing concentrations of nicotine (6 mg/mL, 20.5 mg/mL, and 35 mg/mL) as well as a control group (no exposure to nicotine). These flies were exposed to nicotine in the vials for 7 days before being placed in embryo collection cages, in which we allowed them to lay eggs for 24 hours. After 24 hours, we collected eggs from each group and followed the development of the flies until they hatched. At this stage, we measured lifespan, weight, and fat content.

**Results:** Mothers exposed to nicotine while pregnant laid 56.8% less eggs compared to the control, and the eggs that did survive showed a decrease in weight (by 21%) , fat content (by 14%), and lifespan compared with flies that were never exposed to nicotine.

**Conclusions:** We established that nicotine exposure from electron-cigarette devices has a negative effect on the development and lifespan of *Drosophila melanogaster*.

**Relevance of the Study:** This observation has significant importance because it can be used to educate women on the possible effects of using e-cigarettes as a cessation tool from tobacco cigarettes while pregnant.

**Poster #10**

**Student Name:** Brody Stroup
**Research Topic:** Photoelectric Effect
**University:** Rose State College
**Hometown:** Norman

**Researcher(s):** Brody Stroup
Dept. of Engineering and Science
Rose State College, Midwest City, OK
**Faculty Advisor:** Prof. James Gilbert, Rose State College, Midwest City, OK

# MEASUREMENT OF PLANCK'S CONSTANT BY EXPERIMENTAL REPLICATION OF EINSTEIN'S PHOTOELECTRIC EFFECT

Throughout the development of physics, several observations within the study of light had indicated flaws within its classical description and analysis. These flaws become more evident and lead to the need and development of new ideas for further and more complete explanations. The Photoelectric Effect proposed by Dr. Albert Einstein considered a light beam as a group of quantized or finite particles called photons (light quanta). Considering each photon possessing energy $E$, which relates the light frequency $f$ and a tiny natural constant $h$ (known as Planck's constant) to the light Energy, where $E = h \times f$. This explanation of the quantization of light as applied to the illumination of metals and creating ejected electrons (photo-current) is known as the Photoelectric Effect. This won Einstein a Nobel Prize in Theoretical Physics in 1921.

The objective of this experiment is to replicate Einstein's Photoelectric Effect, demonstrating that the energy of light is proportional to its frequency, and thus measure Planck's constant h by utilizing Einstein's photoelectric equation:

$$E = h \times f = \Phi + K$$

Where $\Phi$ is the metal's work function…energy needed to remove the electron for its atom
and $K$ is the electron's kinetic energy upon its release from the atom.

The equipment used for this experiment consists of a Mercury vapor light source that produces a wide range of known calibrated frequencies by filtering various wavelengths, a photo-emissive material (i.e., metal) to be illuminated by the known light wavelengths, the instrumentation equipment, circuit, and metering needed to measure photocurrents and their associated stopping potentials (backing voltage).

From remote controls, smoke detectors to streetlights, there are many devices that utilize the Photoelectric Effect. Studying this phenomenon is necessary for the complete understanding of light and its many associated applications and technologies.

**Poster #11**

**Student Name:** **Joseph Ummel**
**Research Topic:** **Computational Chemistry**
**University:** **University of Science & Arts of Oklahoma**
**Hometown:** **Blanchard**

**Researcher(s):** **Joseph Ummel**
**Dept. of Chemistry**
**University of Science and Arts of Oklahoma, Chickasha, OK**
**Faculty Advisor:** **Dr. Nicholas Boyde, University of Science and Arts of Oklahoma, Chickasha, OK**

# ORCA SOP: UTILIZATION OF OPEN-SOURCE SOFTWARE IN COMPUTATIONAL CHEMISTRY STUDIES FOR UNDERGRADUATES

Research and development of a standard operating procedure for the quantum chemistry program package ORCA was undertaken. The goal of the standard operating procedure was to develop a guide to ORCA for students with no prior experience in programing or computational work. This software has the benefit of being open-source which provides access to all students. The standard operating procedure was implemented in a collaborative project to investigate the mechanisms of first order nucleophilic substitution reactions. These calculations were completed utilizing a regional supercomputing network. Computational chemistry programs allow undergraduate students to model theories taught in the classroom to solve complex real-world applications. Potential methods for implementation in laboratory and lecture settings at all levels will be discussed further in this report.

**Poster #12**

**Student Name:** Alex X. Arreola
**Research Topic:** Discovering Fungi
**University:** Oklahoma State University
**Hometown:** Coweta

**Researcher(s):** Alex X. Arreola, C. H. Meili, N. H. Youssef, M. S. Elshahed
Dept. of Microbiology and Molecular Genetics
Oklahoma State University, Stillwater, OK
**Faculty Advisor:** Dr. Mostafa Elshahed, Oklahoma State University, Stillwater, OK

# DISCOVERY AND CHARACTERIZATION OF NOVEL FUNGAL DIVERSITY IN THE EQUINE ALIMENTARY TRACT

**Introduction:** Most fungi thrive as free-living organisms, but few can forge symbiotic relationships with their hosts. One of the most enigmatic fungal groups are the anaerobic fungi (AF, phylum Neocallimastigomycota). They reside in the alimentary tract of herbivores and play a crucial role in the digestion and assimilation of ingested plant material. Surprisingly, little is known regarding their scope of diversity and distribution patterns across animal hosts.

**Aims:** To characterize patterns of AF diversity in the equine alimentary tract using DNA sequence-based molecular biology approaches.

**Methods:** We collected over 145 equine manure samples across various geographic regions around the world. I extracted DNA from these samples, used polymerase chain reaction (PCR) to amplify a specific gene (D1/D2 LSU), and sequenced the obtained PCR products. A suite of bioinformatic, phylogenetic, and statistical analyses was performed on the obtained data to assess the novelty, diversity, and community structure of AF within and across samples.

**Results and Conclusions:** My analysis revealed a high level of AF diversity within the equine alimentary tract, as evident by the detection of > 30 different AF genera. A fraction of the sequences obtained belonged to previously unknown genera, indicating that the scope of AF diversity is much broader than previously suggested. Further, my analysis indicated that age and geographical location appear to be the most important factors in shaping AF diversity, degree of novelty, and community composition in equines.

**Societal Impact:** The activity of AF in the herbivorous gut is crucial for the health and growth of their hosts. My study broadens our knowledge of fungal diversity in this ecosystem. Beyond expanding basic knowledge, a solid understanding of AF diversity opens the door for their utilization as dietary supplements for animals raised for human consumption. Indeed, AF may play a critical role in allowing the utilization of low-quality forages for animal feed. Further, the superior plant degradation capacities of AF render them extremely promising agents for plant biomass conversion to biofuels, bioproducts, and biomaterials.

**Poster #13**

**Student Name:** Alisha Asif
**Research Topic:** Cancer
**University:** University of Oklahoma Health Sciences Center
**Hometown:** Edmond

**Researcher(s):** Alisha Asif[1,2,3], F. Neizer-Ashun[1] and R. Bhattacharya[1,2]
[1]Dept. of Obstetrics and Gynecology, University of Oklahoma Health Sciences Center, Oklahoma City, OK; [2]Stephenson Cancer Center, University of Oklahoma Health Sciences Center, Oklahoma City, OK; [3]Dept. of Chemistry, Oklahoma City University, Oklahoma City, OK
**Faculty Advisor:** Dr. Resham Bhattacharya, University of Oklahoma Health Sciences Center, Oklahoma City, OK

# ROLE OF KRCC1 IN X-IRRADIATION INDUCED DAMAGE

**Introduction:** The lysine rich coiled-coil 1 (KRCC1) is overexpressed in ovarian cancer which correlates with poor overall patient survival. Silencing KRCC1 inhibits cellular plasticity, invasive properties, and enhances DNA damage resulting in apoptosis and reduced tumor growth. In vivo studies revealed that silencing KRCC1 further sensitizes tumors to Cisplatin. Although KRCC1 is involved in multiple pathways, its biological function is unknown. Recent studies from our lab suggest that KRCC1 may be involved in the DNA damage response. Here, we sought to elucidate the role of KRCC1 in response to x-irradiation (IR). IR induces double strand breaks (DSB) which leads to activation of checkpoint and subsequent repair. We hypothesize that silencing KRCC1 will exacerbate IR induced damage, impair checkpoint, and decrease repair of cancer cells.

**Methods:** To elucidate the role of KRCC1 silencing in combination with IR, cancer cells were transfected with siRNA and exposed to IR at different doses. We performed immunofluorescence (IF) and western blot to evaluate DNA damage response markers.

**Results:** In control cells, exposure to IR resulted in DNA damage as evidenced by γH2AX foci which were resolved after 24-48 hours. However, in KRCC1 silenced cells, we observed persistent DNA damage after 24-48 hours. We observed impaired checkpoint in KRCC1 silenced cells as evidenced by a decrease in phosphorylation of CHK1 at Ser296 and stabilization of CDC25A.

**Conclusion:** All together, our results suggest that KRCC1 may play a vital role in the DNA damage response and repair of IR induced damage. These results also suggest inhibition of KRCC1 may present a unique avenue for future therapeutic consideration.

**Funding:** This work was partly supported by the following: CURE, W81XWH-18-1-0073 and W81XWH18-1-0054 grants from the Department of Defense, and by a Oklahoma Center for Adult Stem Cell Research grant awarded to RB.

**Poster #14**

**Student Name:** Rio B. Bonham
**Research Topic:** Irrigation Management & Sensor Technology
**University:** Oklahoma State University
**Hometown:** Tishomingo

**Researcher(s):** Rio B. Bonham, M. Mehata, S. Datta and S. Taghvaeian
Dept. of Biosystems and Agricultural Engineering
Oklahoma State University, Stillwater, OK
**Faculty Advisor:** Dr. Saleh Taghvaeian, Oklahoma State University, Stillwater, OK

# EFFECTIVENESS OF SOIL MOISTURE SENSORS TO IMPROVE IRRIGATION MANAGEMENT

Irrigating agricultural crops is the largest user of freshwater in Oklahoma, with an expected share of 36% of the total water demand by 2060. At the same time, our limited water resources are threatened by frequent droughts and increasing competition among users. It is now more important than ever for agricultural water resources to be conserved at every opportunity possible. One such opportunity is to manage irrigation more precisely using smart technology such as soil moisture sensors. However, smart technology has not been widely adopted. A recent survey reported that only 5% of irrigated land in Oklahoma was managed using soil moisture sensors. The goal of this research project was to investigate how to better implement soil moisture sensors into irrigated operations, particularly at sites with high salinity and clay content which can cause inaccurate readings in commonly used sensors.

The project was conducted during the 2020 and 2021 growing seasons in the West-Central, Southwest, and Panhandle regions of Oklahoma. Commonly used commercial sensors were installed at several experimental fields in each region, varying widely by climate, crop, soil clay content, and salinity. The data provided by the sensors in each field was recorded and analyzed to determine their usefulness in making irrigation decisions. Additionally, soil samples from the fields were collected and analyzed in the lab for soil moisture, salinity, texture, and pH. Daily weather data were retrieved from Oklahoma Mesonet stations near each field. The results showed that the sensors were generally effective in near real-time monitoring of soil moisture at multiple root zone depths. However, their accuracy degraded rapidly as the clay content and salinity increased, as high as 30% error in these conditions. Almost all the sensors overestimated soil moisture, which could lead to underirrigation and possibly yield-loss. Among the two different calibrations provided by the sensor manufacturer, the texture-adapted combined calibration performed better than the default calibration. The main finding is that these sensors are effective when clay content and salinity are low, but site-specific calibration is required as these two parameters increase.

**Poster #15**

**Student Name:** Noah G. Bridges
**Research Topic:** Businesses' Financial Outlook
**University:** University of Oklahoma
**Hometown:** Norman

**Researcher(s):** Noah G. Bridges, A. Gonzalez and S. Rodriguez Gonzalez
School of Industrial and Systems Engineering
University of Oklahoma, Norman, OK
**Faculty Advisor:** Dr. Andres Gonzalez, University of Oklahoma, Norman, OK

# ENHANCING BUSINESS RESILIENCE WITH DYNAMIC NETWORK MODELS

Financial markets are characterized by frequent upheavals, requiring the firms within them to weather uncertain and suboptimal conditions. Researchers model complex systems like financial markets and ecological systems with temporally dynamic networks to analyze the time-varying behavior and descriptive properties of these systems. One frequently studied property of these networks is resilience to disruptions – that is, the ability of a network to withstand and recover from disturbances.

This project begins with the creation of a null model – a randomly generated network – that mimics the original network's time-dynamic topology and long-term behavior. This model identifies predictive parameters of network behavior, allowing its resilience patterns to be analyzed and manipulated. Specifically, the model's topology is rewired to ascertain how changing the quality, as measured by connectedness, or quantity of contractual partners could enhance a company's long-term financial viability.

Based on these analyses, it is anticipated that firms occupying a more central, connected position within the network will be more resilient to economic disruptions than peripheral nodes. That is, connections with high-influence nodes could increase the resiliency of a firm within the network. Additionally, the rewiring scheme tends to deemphasize the role of hubs within the network while increasing resilience. Consequently, the robustness of the network is expected to increase as the degree distribution becomes more uniform, perhaps by reducing the connectivity's dependency on a few densely connected nodes, thereby slowing the propagation of nodal failure through the network.

In conclusion, it is anticipated that a firm's resilience is related to the number, centrality, and diversity of its contracting partners. Developing relationships with connected and established firms is likely to promote persistent financial solvency. However, given the volatility possible from placing all of one's contracts with only a few companies, diversifying one's contracting partners will likely reduce risk, as a single failure will not result in insolvency. In a market shaped by frequent upheavals and uncertainty, this research provides quantitatively supported strategies for increasing both market-wide resilience to disruptions and individual firms' likelihood of sustaining extended financial stability.

**Poster #16**

**Student Name:** Cody B. Cummins
**Research Topic:** Tactical Wellness
**University:** Oklahoma State University
**Hometown:** Oklahoma City

**Researcher(s):** Cody B. Cummins
Dept. of Nutritional Sciences
Oklahoma State University, Stillwater, OK
**Faculty Advisor:** Dr. Jill Joyce, Oklahoma State University, Stillwater, OK

# RESULTS OF THE ROTC AND NUTRITION/ KINESIOLOGY (RANK) NEEDS ASSESSMENT

**Introduction/Objective:** Military officers report sources of nutrition information most often being popular media and least often being doctors or dietitians. The majority of officers state the military places too little emphasis on nutrition and there needs to be more of a focus on changing Soldiers' nutrition. They also suggest including nutrition as part of basic training. There is need to increase opportunities for nutrition education for military personnel. Collaborations between university departments and ROTC programs present as an ideal opportunity. Thus, the purpose of the RANK needs assessment was to determine interest, perceived importance, desired components, and foreseen challenges to a nutrition and physical training education program for university ROTC programs by cadets (students) and cadre (instructors).

**Methods:** Two focus groups were conducted in November 2020 with cadets (n=5) and cadre (n=5) in OSU ROTC programs. Questions covered topics including demographics, level of interest, perceived importance, logistics of classes, interest in additional services, and impact on career. Thematic analysis was performed using video recordings and notes.

**Results/Conclusions:** Out of 5 (highest interest), cadets scored interest as 4.8 and importance as 4.2. Cadre scored interest and importance as 5. Cadets and cadre were consistent in responses regarding class logistics. They recommended classes be offered in person, livestreamed, and recorded to maximize reach and include PowerPoint slides, but remain interactive. They reported no need for incentives. A health challenge aspect was desirable. Class length and frequency was suggested at one hour every week of the semester. Cadets foresaw several major benefits, while cadre provided a long list of benefits for cadets' future careers.

**Relevance:** University departments collaborating with their respective ROTC programs to provide nutrition/ physical training classes is of high interest and importance to cadets and cadre with countless significant benefits to the careers of these future military leaders.

**Poster #17**

**Student Name:** Ann Marie E. Flusche
**Research Topic:** Cancer Metabolism
**University:** The University of Tulsa
**Hometown:** Tulsa

**Researcher(s):** Ann Marie E. Flusche
Dept. of Chemistry and Biochemistry
The University of Tulsa, Tulsa, OK
**Faculty Advisor:** Dr. Robert Sheaff, The University of Tulsa, Tulsa, OK

## DETERMINING MATCHA TEA'S POTENTIAL FOR FIGHTING CANCER

Green tea is one of the most ancient and popular beverages consumed around the world. Matcha green tea (a widely known powdered form) is recognized for its potential antioxidant, anti-aging, and weight loss properties. Recently, a study followed the metabolic effects of Matcha on breast cancer cells. The results showed that Matcha reduces mitochondrial metabolism, as well as glycolysis, maintaining cancer cells in a metabolically quiescent state. However, the underlying molecular mechanisms and components behind its proposed effects remain largely unknown. Cancer cells autonomously alter their course through various metabolic pathways to meet increased bioenergetic and biosynthetic demands required for cancer proliferation and survival. Our lab discovered that metabolic pathways utilized for cancer survival and growth are inhibited when Matcha is present. In addition, Matcha targets cellular metabolism by blocking hexokinase phosphorylation of glucose, leading us to hypothesize that Matcha's anti-cancer activity may be due in part to inhibition of glucose metabolism. Immortalized cancer cells are glucose addicted, utilizing aerobic glycolysis (Warburg effect) to produce sufficient ATP and biomass. To test our hypothesis, we cultured Human Embryonic Kidney – 293 cells (which follow the Warburg effect), varied the growth media composition to force use of specific metabolic pathways, incubated the cells with varied Matcha concentrations, and measured Adenosine Triphosphate (ATP) production using the CellTiter GloTM Assay. We observed a dose-dependent decrease in ATP production when media with glucose and Matcha was introduced to the cells, but we saw no effect when the cells were treated with the galactose media and Matcha. Our results suggest that Matcha is a positive inhibitor of ATP production in cultured cancer cells by targeting glucose metabolism, which may be important to understanding the novel therapeutic potential of Matcha in chemotherapy treatment. In the future, we plan to identify the component within Matcha that is inhibiting hexokinase as well as test our work in tissue-specific cancer cell cultures. While it may be tempting to think modern medicine has progressed beyond herbal remedies, our research serves to address natural products' potential for fighting cancer. Identifying natural chemotherapeutic agents could help us develop safer treatments for cancer patients.

Funding: National Science Foundation (NSF), American Chemical Society (ACS), OK-LSAMP, Tulsa Undergraduate Research Challenge (TURC), and Chemistry Summer Undergraduate Research Program (CSURP).

**Poster #18**

**Student Name:** Lydia Hashemi
**Research Topic:** HPV-Induced Cancer & Fruit Flies
**University:** University of Oklahoma
**Hometown:** Tulsa

**Researcher(s):** Lydia Hashemi[1], M. E. Ormsbee[1], P. J. Patel[1], J. A. Nielson[1], J. Ahlander[2] and M. Padash Barmchi[1]
[1]Dept. of Biology, University of Oklahoma, Norman, OK;
[2]Dept. of Natural Sciences, Northeastern State University, Broken Arrow, OK
**Faculty Advisor:** Dr. Mojgan Padash Barmchi, University of Oklahoma, Norman, OK

# A *DROSOPHILA* MODEL OF HPV16-INDUCED CANCER FOR UNDERSTANDING DISEASE MECHANISM AND THERAPEUTIC DEVELOPMENT

Cervical cancer has poor survival rate in advanced disease. This is due to unavailability of highly effective therapies including molecularly-targeted therapeutics. Despite availability of Human Papilloma Virus (HPV) vaccines to prevent highly cancer-inducing HPV 16 and 18 viral infections responsible for 70% of cervical cancer, a reduction in rate of cervical cancer has been slow. This is due to low vaccination rates, long latency underlying HPV infection, and inability of vaccines to treat pre-existing infections. Hence, there is still a significant need to develop new therapeutic strategies including molecularly-targeted drug treatments for HPV-induced cancers.

Here in this study, we used the tissue-specific expression technique, Gal4-UAS, to establish the first *Drosophila* model of HPV16-induced cancer. Using this technique, we expressed HPV16 oncogenes E5, E6, E7 and the human E3 ligase (hUBE3A) exclusively in epithelia of *Drosophila* eye, which allows simple phenotype scoring without affecting the viability of the organism. Co-expression of hUBE3A with oncogenes was necessary as it is known to be needed by HPV oncogenes in human cells to cause cancer.

We found that similar to human cells, hUBE3A is essential for cellular abnormalities caused by HPV16 oncogenes in flies. Additionally, we discovered that several proteins targeted for degradation by HPV16 oncoproteins in human cells were also degraded in the *Drosophila* epithelial cells. Similarly, cell polarity and junction were compromised in the presence of HPV16 oncogenes. Cells acquired cancer-like properties and exhibited malignant behavior such as extending protrusions and migrating away from the place of origin to distant sites.

Our findings suggest that, given high conservation of genes and signaling pathways between humans and flies, the *Drosophila* model of HPV16- induced cancer could serve as an excellent complementary model to the existing models of the disease. This model overcomes the limitations of other models of HPV-induced cancer such as large-scale in vivo genetic and drug screening. Hence it can pave the way for better understanding of disease mechanism as well as identification of novel therapeutic targets for treatment of cervical cancer and perhaps all HPV-induced cancers, nationwide and globally.

**Poster #19**

**Student Name:** Allison P. Hussin
**Research Topic:** 3D-Printed Electrochemistry
**University:** The University of Tulsa
**Hometown:** Bixby

**Researcher(s):** Allison P. Hussin
Dept. of Chemistry and Biochemistry
The University of Tulsa, Tulsa, OK
**Faculty Advisor:** Dr. Gabriel LeBlanc, The University of Tulsa, Tulsa, OK

# ELECTRO-ORGANIC SYNTHESIS USING 3D-PRINTED ELECTRODES

**Introduction:** Electro-organic synthesis is a promising field of research, with the use of electricity allowing experiments to be carried out in a safer, inexpensive, more controlled way. However, many challenges face this line of work, such as the expensive equipment needed, rigid electrodes used for experiments, and limited reaction area; 3D printing can alleviate some of these issues.

**Aims:** To determine the best activation methods to maximize the efficiency of 3D-printed electrodes as compared to standard electrodes, to design geometries that maximize surface area, and to prove these electrodes can carry out a synthesis reaction.

**Methods:** Electrodes were soaked in KCl, NaOH, and $NaBH_4$ at differing times and concentrations. Chronoamperometry experiments were carried out to determine the best activation method. Electrode geometries were designed via Fusion 360, printed, and compared using cyclic voltammetry. The ACT-mediated electrochemical oxidation of solketal was used as a proof-of-concept reaction. Synthesis trials were carried out using both a potentiostat and ElectraSyn device. Reaction products were characterized using H1-NMR.

**Results:** Electrodes activated using a battery-powered 1M KCl method over a 24-hour period had the highest end current after multiple trials; a 1-hour 4M NaOH soak showed similar results. All methods had higher end currents as compared to unactivated electrodes. Additionally, electrode geometries with the highest surface area had the most amount of current achieved.

**Conclusion:** We established that the best method of activation for 3D-printed electrodes was a battery-powered 1M KCl method. Additionally, we found more current passed through electrodes with more surface area. Further synthesis trials are still being carried out in our laboratory.

**Relevance of Study:** Electro-organic synthesis is one method by which organic molecules vital to drugs and other pharmaceutical endeavors are produced. Proving the success of this method with 3D-printed electrodes that offer more flexibility in their design will help to solve some of the major problems facing the field, hopefully encouraging the widespread use of electro-organic synthesis.

**Funding:** This project was supported by the Tulsa Undergraduate Research Challenge (TURC), the Chemistry Summer Undergraduate Research Program (CSURP), and TU's Office of Research and Sponsored Programs.

**Poster #20**

**Student Name:** Mahaalakshmi Narayanan
**Research Topic:** Wildfires & Transmission Towers/Lines
**University:** University of Oklahoma
**Hometown:** Broken Arrow

**Researcher(s):** Mahaalakshmi Narayanan
School of Civil Engineering and Environmental Science
University of Oklahoma, Norman, OK
**Faculty Advisor:** Dr. Muralee Muraleetharan, University of Oklahoma, Norman, OK

## IMPACTS OF INTENSE WILDFIRES ON ELECTRICAL TRANSMISSION TOWERS AND LINES

Transmission towers are steel structures that support overhead powerlines. These towers and lines are an integral part of the electric power delivery system. Engineers are increasingly concerned about the performance of these towers and lines during frequent and long duration wildfires. A long duration wildfire with high temperatures can affect the steel in the towers and the power lines, causing them to weaken and collapse. This leads to loss of power to large communities. According to a report by the U.S. Environmental Protection Agency, wildfire frequencies have increased. Therefore, studying the effects of wildfires on transmission tower-line systems is crucial.

During a wildfire, average temperatures can reach around 1,500oF, whereas steel structures are typically designed to withstand temperatures around 800oF. Moreover, the wind generated by a wildfire can also damage these towers, so its effects must also be considered. The proposed analysis will be done by using Fire Dynamics Simulator (FDS) and ANSYS. Firstly, in FDS, the wildfire parameters are defined, as well as the desired output; for this study the desired output is temperature in each tower member. After, the tower is modeled in ANSYS. To this model, the thermal load and the fire-generated wind load is applied. Once this is done, the simulation runs, and critical points of the system can be discerned.

This study is still undergoing, but there are some anticipated results. Since wildfires are concentrated near the base of the towers, the steel at the base of the towers will most likely soften first. Once it has softened, the member loses much of its strength and will no longer be able to support the rest of the tower. From there, tower collapse is expected to be imminent. When transmission lines are exposed to high temperatures, the tensile strength of the lines will decrease. Simultaneously, the lines also start elongating more, causing more sag. When this is paired alongside fire-generated winds, the lines most probably will fail at the connection between itself and the tower. Understanding how transmission tower-line systems could fail during wildfires can help us to better develop solutions to combat these adverse reactions.

**Poster #21**

**Student Name:** Lauren Nguyen
**Research Topic:** Antibiotic Resistance
**University:** University of Oklahoma
**Hometown:** Oklahoma City

**Researcher(s):** Lauren Nguyen, I. Leus and H. Zgurskaya
Dept. of Chemistry and Biochemistry
University of Oklahoma, Norman, OK
**Faculty Advisor:** Dr. Inga Leus, University of Oklahoma, Norman, OK

# MECHANISM OF ANTIBIOTIC RESISTANCE OF A HUMAN PATHOGEN *ACINETOBACTER baumannii*

Over the years, multidrug antibiotic resistance has become a serious public threat. Bacteria have become resistant to multiple antibiotics and cause infections that are effectively untreatable. The Organization for Economic Co-Operation and Development (OECD) predicts that in the next 30 years, up to 2.4 million people will die throughout Europe and North America because of antibiotic resistant bacterial infections.

One species in particular, *Acinetobacter baumannii*, has become a significant issue in hospitals worldwide, with the Infectious Disease Society of America and the Center for Disease Control classifying it as one of the top six most important multidrug resistant organisms in hospitals. Researchers have found that the major molecular mechanism underlying the antibiotic resistance of this bacterium is active efflux of antibiotics from cells. Molecular machines called efflux pumps remove antibiotics from cells and prevent their activities. Two efflux pumps, known as AdeABC and AdeIJK contribute heavily to the resistance of two multidrug resistant clinical isolates.

Our project seeks to characterize the effect of inactivation of these two pumps on antibiotic resistance of *A. baumannii*, and on the genes encoding other efflux pumps, A1S_1799-1800 and A1S_1772-73. For this purpose, we constructed mutant cells lacking these pumps in *A. baumannii* ATCC17978 strain, measured susceptibilities to different antibiotics of the constructed strains and characterized their morphology and physiology under conditions that bacteria experience during infections in humans such as oxidative, bile salts, acidic, osmotic, high temperature and low iron stress.

We found that inactivation of these pumps did not affect their susceptibility to various antibiotics but led to defective growth under several stress conditions. Growth of the wild-type strain was inhibited by low iron condition, bile salts, and osmotic shock. Deletion of A1S_1799-1800 led to significant defects in growth under all investigated stress conditions, while deletion of A1S_1772-73 caused defects in growth under acidic and bile acid stress. Furthermore, acidic and bile acid stress conditions inhibited growth of all efflux-deficient strains. We conclude that efflux pumps are crucial to the survival of *A. baumannii* during infection, and that new antimicrobials could target processes that allow bacteria to survive in human hosts.

**Poster #22**

**Student Name:** Daniel R. Reed
**Research Topic:** Antimicrobials, Microbiology
**University:** Oklahoma State University
**Hometown:** Sapulpa

**Researcher(s):** Daniel R. Reed[1], T. L. Nelson[2], G. A. Cook[2], F. R. Champlin[3] and E. I. Lutter[1]
[1]Dept. of Microbiology and Molecular Genetics, Oklahoma State University, Stillwater, OK; [2]Dept. of Chemistry, Oklahoma State University, Stillwater, OK; [3]Dept. of Biochemistry and Microbiology, Oklahoma State University Center for Health Sciences, Tulsa, OK
**Faculty Advisor:** Dr. Erika Lutter, Oklahoma State University, Stillwater, OK

## NOVEL MELANIN INSPIRED COMPOUND REVEALS GRAM-POSITIVE SPECTRUM BY MEMBRANE-DIRECTED MECHANISM

The melanin inspired compounds (EIPE) possess a core that provides scaffolding for the attachment of various functional groups. Antibiotic resistance remains a threat as more pathogenic bacteria develop resistance to last line drugs like methicillin. This creates a need for novel compounds to be developed to combat resilient pathogens like Methicillin Resistant *Staphylococcus aureus* (MRSA). The purpose of this study is to determine the antibacterial nature of the hydrophobic (EIPE-1) and hydrophilic (EIPE-HCl) melanin inspired derivatives. A standardized disc agar diffusion bioassay was performed to qualitatively compare the susceptibility and resistance levels of 12 gram-positive and 13 gram-negative bacteria to EIPE-1 and EIPE-HCl. The hydrophobic derivative EIPE-1 exhibited a gram-positive spectrum including two methicillin resistant *Staphylococcus aureus* (MRSA) strains, while the hydrophilic derivative EIPE-HCl showed zero antibacterial properties. Turbidimetric growth curves were conducted to investigate the EIPE-1 mechanism of action. Bacteriolysis occurred immediately upon treatment for *Staphylococcus epidermidis* SK01 and later at the five-hour mark for *B. subtilis* ATCC 6633, likely resulting from a membrane-directed attack. Minimal inhibitory concentration (MIC) and minimal bactericidal concentration (MBC) bioassays were employed to quantitatively determine potency of EIPE-1. All gram-positive bacteria tested showed susceptibility, while again, gram-negative bacteria were resistant. EIPE-1 exhibited minimum inhibitory concentrations (MICs) below 2 µg/mL against all gram-positive bacteria, including two MRSA strains contrary to MIC values greater than 128 µg/mL against gram-negative bacteria. These data suggest that EIPE-1 is a novel compound that possesses a spectrum of gram-positive antibacterial activity. Further MICs and MBCs were conducted anaerobically with *Clostridium difficile*, and we found that molecular oxygen does not affect the gram-positive spectrum of EIPE-1. The resistance of 13 gram-negative bacteria is likely due to their intrinsic outer membrane exclusion properties for hydrophobic molecules.

## ESTABLISHED PROGRAM TO STIMULATE COMPETITIVE RESEARCH

The Oklahoma Established Program to Stimulate Competitive Research (EPSCoR) program was initiated by the National Science Foundation in 1985 to strengthen Oklahoma's exploration and growth in science, technology, engineering and mathematics. Oklahoma NSF EPSCoR's central goal is to increase the state's research competitiveness through strategic support of research instruments and facilities, research collaborations, and integrated education and research programs.

The national NSF EPSCoR program is designed to benefit states, including Oklahoma, that have historically received lesser amounts of competitive research and development funding. Twenty-eight states, the Commonwealth of Puerto Rico, the Territory of Guam, and the United States Virgin Islands are currently eligible to participate.

EPSCoR provides support for key research areas at Oklahoma's public universities, while also establishing partnerships with higher education, government, and industry to affect lasting progress in the state's research infrastructure, research and development capacity, and R&D competitiveness. The goal is to stimulate lasting research infrastructure improvements in Oklahoma.

On July 1, 2020, the National Science Foundation awarded Oklahoma a new $20 million EPSCoR Research Infrastructure Improvement (RII) Award that will support research and education programs across the state. During the five-year award, a team of more than 50 researchers from universities across the state will develop and test science-based solutions for complex problems at the intersection of land use, water availability, and infrastructure. The grant is also designed to provide education and workforce development programming to more than 150,000 Oklahomans of all ages.

Oklahoma NSF EPSCoR is funded by the National Science Foundation and Oklahoma State Regents for Higher Education.

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# OKLAHOMA

EPSCoR researchers are performing cutting-edge science and making a difference in Oklahoma and the world. Our environmental research is providing important answers about the changing planet and how we live in it. We're also training a diverse and skilled STEM workforce to ensure that Oklahoma's emerging tech-based businesses and research labs have a high-quality applicant pool to draw from for years to come. More than 132,000 Oklahomans have been served in the past ten years; 31% were underrepresented minorities and 58% women.

# OKLAHOMA NSF EPSCoR

## NETWORK COLLABORATORS

- Cameron University
- College of the Muscogee Nation
- East Central University
- i2E
- Langston University
- Noble Research Institute
- OK Career Tech/ Pontotoc Tech Center
- OK 4-H
- OK Museum Network
- OK State Regents for Higher Education
- Oklahoma State University
- Peoria Tribe
- Science Museum OK
- Southwestern OSU
- University of Oklahoma
- University of Tulsa

## PROGRAM OVERVIEW

### NSF EPSCoR TRACK-1

- **Award #OIA-1946093 (2020-2025)**
- **Socially Sustainable Solutions for Water, Carbon & Infrastructure Resilience in Oklahoma ($S^3OK$)**
- **PI: Kevin Wagner, OSU**

Oklahoma NSF EPSCoR researchers are innovating a new, interdisciplinary, inter-institutional approach to develop and test science-based solutions for complex problems at the intersection of land use, water availability and infrastructure. Researchers are investigating:

- How Oklahoma's seasonal and subseasonal weather patterns are likely to shift over time and what those implications might be;
- terrestrial water and carbon dynamics as they relate to climate change and land management;
- water reuse and sustainability; and
- infrastructure implications for these topics.
- The social dynamics framework team is integrating the science team's perspectives with those of opinion leaders and citizens across the state to find solutions in the overlapping areas being investigated.

## Predicting & Preparing for Cold Air Outbreaks

OK NSF EPSCoR researchers are investigating the development of cold air outbreaks (CAOs) in the Great Plains region. The team's goal is to provide emergency managers and the public with important lead-time to prepare for these large-scale, extreme cold events. Our researchers are examining how CAOs form and evolve, while also studying the potential for their predictability. Through the team's work, harmful socioeconomic, environmental, and infrastructural impacts, such as widespread power outages, may be mitigated.

Researchers are looking at additional atmospheric variables that could yield signals to enhance predictability potential, and also developing a suite of numerical weather models to further assess prediction capabilities.

*Revised 2.22.22*

# Impact of Program

## Research

- $470 Million in New Research Funding Generated
- $167 Million Active Grant Awards

## Workforce Development

- 120 New Technologies
- 38 Companies & 9 Marketed Products
- 34 Patents & 9 Copyrights
- 5 Tribal College Faculty Positions

## Outreach & Education

- 132,000 Oklahomans Served since 2013 (41,000 Underrepresented Minorities & 76,000 Women)
- 50 Institutions Served via OneOklahoma Cyber, Facilitating over $400 Million in External Funding
- 29 New University Faculty Hired

### NEW RESEARCH FUNDING GENERATED FOR OKLAHOMA

| OKLAHOMA NSF EPSCOR RII TRACK-1 AWARDS | | NEW FUNDS GENERATED* |
|---|---|---|
| 2001-2008 | $16 Million | $ 50 Million |
| 2008-2013 | $15 Million | $ 70 Million |
| 2013-2020 | $21 Million | $332 Million |
| 2020-2025 | $20 Million | $ 18 Million |
| | **$72 Million** | **$470 Million** |

**Does not include: NSF RII Award or State Funds*

### ACTIVE OKLAHOMA EPSCoR/IDEA AWARDS

| PROGRAM | AWARD | TYPE OF AWARD | AMOUNT |
|---|---|---|---|
| NSF | EPSCoR | Research Infrastructure Track-1 | $ 20 Million |
| NSF | EPSCoR | Research Infrastructure Track-2 (2 Awards) | $ 9.5 Million |
| NSF | EPSCoR | Research Infrastructure Track-4 (8 Awards) | $ 1.7 Million |
| NASA | EPSCoR | Research Infrastructure (3 Awards) | $ 1.9 Million |
| DOE | EPSCoR | Research Infrastructure | $ 0.8 Million |
| NIH | IDeA | COBRE (9 Awards) | $ 94 Million |
| NIH | IDeA | OSCTR | $ 20 Million |
| NIH | IDeA | INBRE | $ 19 Million |
| | | **Total Funds** | **$167 Million** |

# OKLAHOMA NSF EPSCoR

is proud to sponsor Research Day at the Capitol
& other research, education & outreach programs
that strengthen Oklahoma by encouraging exploration & growth
in science, technology, engineering & mathematics.

RESEARCH

OKLAHOMA EPSCoR

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