

McPherson College  
Natural  
Science  
Research  
Forum  
Division of Science and Technology

1:00pm, April 26, 2019  
Mingenback Theater



M<sup>c</sup>Pherson College  
The 36<sup>th</sup> Natural Science Research Forum

<b>1:00 – 1:05</b>	<b>Welcome and Introductions</b>
<b>1:05 – 1:20</b>	<b>Micaila Curtis:</b> The Effectiveness of Cannabidiol as an Antibiotic against Gram-positive and Gram-negative Bacteria
<b>1:20 – 1:35</b>	<b>Keisha England:</b> Relationship between bacterial community structure and the performance of microbial fuel cells in Kansas soil samples
<b>1:35 – 1:50</b>	<b>Jordon Henderson:</b> The Effects of Varying Temperatures on the Viral Infection Rates of <i>Escherichia coli</i> and <i>Bacillus subtilis</i>
<b>1:50 – 2:05</b>	<b>Nathen Jones:</b> Investigating photosynthetic activity in response to increased atmospheric CO <sub>2</sub> levels and increased leaf level temperatures in <i>Ravenea rivularis</i>
<b>2:05 – 2:20</b>	<b>Sydney Lang:</b> Exploring the effects of <i>Pseudomonas aeruginosa</i> on mating behaviors in the wolf spider <i>Rabidosa punctulata</i>
<b>2:20 – 2:35</b>	<b>Break</b>
<b>2:30 – 2:45</b>	<b>Samantha Nelson:</b> The antibacterial activity of essential oils from <i>Tagetes erecta</i> and <i>Thuja occidentalis</i>
<b>2:45 – 3:00</b>	<b>Cameron Oram:</b> The effect of variable environments on aggressive behavior in <i>Betta splendens</i>
<b>3:00 – 3:15</b>	<b>Devrie Sombers:</b> DNA Fingerprinting
<b>3:15 – 3:30</b>	<b>Kaitlynn Usdansky:</b> Weight Lifting Affects the EMG Activity of the Flexors and Extensors of the Legs
<b>3:30 – 3:45</b>	<b>Parkes Wolters:</b> Measuring the Relationship Between Body Condition and Body Composition in Two Kansas Spider Species
<b>3:45 – 4:00</b>	<b>Soren Yarnall:</b> The affects of hydrocarbon contamination on the soil microbial consortia from Quivira National Wildlife Refuge
<b>Dec. 2018</b>	<b>Alexis Lynn:</b> Volatile compounds in wine before and after imbibition  <b>Trenton Smith:</b> How long after a carrion beetle feeds on a beef carcass can you recover identifiable beef specific DNA?

# The Effectiveness of Cannabidiol as an Antibiotic against Gram-positive and Gram-negative Bacteria

Micaila Curtis

CBD is a non-psychoactive compound extracted from the stem, stalk, leaves, and flowers of the *Cannabis sativa* plant. Literature suggests a great number of medicinal benefits for CBD, including anti-inflammatory, antipsychotic for motivation disorders such depression or anxiety, and antibacterial properties. The study utilized the disk diffusion method to observe the antibacterial activity of CBD on gram-negative and gram-positive bacteria. Results suggested that CBD was not active against the strains of *S. aureus*, *S. epidermidis*, and *E. coli* at 2.0 mg/ L concentration. Upon conclusion, an extensive literature search led to a possible explanation for the selective antibacterial properties of CBD. MDR strains of bacteria that were susceptible to CBD according to literature, all had over-expressed efflux pump genes. The bacteria in this experiment lacked the over expression of those genes. In order to understand the role of CBD, as an antibiotic, future researchers should consider the over expression of the efflux pump gene when planning their studies.

**Keywords:** *Cannabidiol, cannabinoids, CBD, Staphylococcus aureus, Staphylococcus epidermidis, Escherichia coli, MRSA, antibiotic resistant, MDR, bacterial efflux pumps*

# **Relationship between bacterial community structure and the performance of microbial fuel cells in Kansas soil samples**

**Keisha England**

Microbial fuel cells (MFC) harvest energy from renewable resources which allows for obtaining clean and renewable energy. In this research soil samples from a freshwater and a salt marsh source were used as the source of energy for the microbial fuel cells. The bacterial community was analyzed using shotgun sequencing to find differences among the soil samples. The overall energy output from the MFCs were analyzed for thirty days to find which sample produced more energy. It was found that the samples did have two significantly different bacterial communities. The salt marsh samples produced more power over the trial period but was not significantly more than the freshwater samples. This suggest that over a longer period of time salt marsh samples may produce more power.

**Keywords:** *Microbial fuel cell, Salt marsh, freshwater*

# **The Effects of Varying Temperatures on the Viral Infection Rates of *Escherichia coli* and *Bacillus subtilis***

**Jordon Henderson**

With the increase in the amount of medical cases involving antibiotic resistant bacteria, new treatments are needed to combat this new wave of diseases. The most viable option is quickly becoming bacteriophage therapy. Equipped with a series of natural processes, bacteriophages are naturally better equipped to combat bacterial infections than antibiotics. The purpose of this paper is to observe how temperature affects the effectiveness of the bacteriophages while infecting *Escherichia coli* and *Bacillus subtilis* using the Plaque Assay Method. The Plaque Assay Method involves using the number of plaque forming units (PFUs) and the concentration of the phage solution to determine the number of PFUs per milliliter of the phage stock solution. The research was not able to produce any conclusive results with a failure to produce plaques or bacteria cultures. Further literature research was able to explain possible reasons for this outcome. Further experimental research is needed to better determine to exact reason(s) and produce quantifiable results.

**Keywords:** *bacteriophage therapy, Escherichia coli, Bacillus subtilis, Plaque Assay Method, PFU*

# **Investigating photosynthetic activity in response to increased atmospheric CO<sub>2</sub> levels and increased leaf level temperatures in *Ravenea rivularis***

**Nathen Jones**

The *Ravenea rivularis* response to increasing global CO<sub>2</sub> concentrations coupled with increased leaf level temperatures was explored in a three-part study evaluating real time photosynthetic responses to changing environmental elements facing the plants in today's climate. In the first segment of the research, controls for the experiment were a temperature setting of 26°C, and a CO<sub>2</sub> of 400 ppm, per the current global average. The vapor pressure deficit was set at 1.4 units. The palms were individually exposed to 15 separate light levels ranging from 0, or, absolute darkness, to 2000 μmol mol<sup>-1</sup>. In each test, the palms began to decrease photosynthetic activity near the 1800 μmol mol<sup>-1</sup> mark. The data I recovered from the LI 6800F indicated the palms were the most productive between 1400 μmol mol<sup>-1</sup> and 1600 μmol mol<sup>-1</sup> ppm. Because of this, I used 1500 μmol mol<sup>-1</sup> for the second stage of testing. Stage two of the project was to determine the CO<sub>2</sub> saturation level for the *Ravenea rivularis*. In stage two, the light setting of 1500 μmol mol<sup>-1</sup> was used as a control as well as the temperature of 26°C, and a controlled vapor pressure deficit of 1.4 units. The established climate controls were applied individually to each palm. The second stage showed the *Ravenea rivularis* ability efficiently sequester CO<sub>2</sub> at the 1500 μmol mol<sup>-1</sup> light level. The third and final stage of the experiment utilized data from last two segments of the experiment, the controls were set at 1500μmol mol<sup>-1</sup>, 400ppm CO<sub>2</sub>, with the 1.4 VPD. This time temperatures were increased at the leaf level. Beginning with 24°C, I increased the temperature by 4°C until I had a range of 24-40°C. Each of the five palms responded in a comparably positive manner. With each increase in the temperature, the palms continued to fix more and more CO<sub>2</sub> nearly doubling the amount of CO<sub>2</sub> sequestration for each specimen by the 40°C temperature mark from an average of 4.9 to around 10.3.

**Keywords:** *Ravenea rivularis*, Carbon Fixation, IPCC, Photosynthesis, Licor 6800F.

# **Exploring the effects of *Pseudomonas aeruginosa* on mating behaviors in the wolf spider *Rabidosa punctulata***

**Sydney Lang**

Variation in mating behaviors attempt to maximize fitness individual fitness for each of the sexes across different contexts. Mate choice by females attempts to maximize their fitness either indirectly by enhancing offspring quality, or directly through gains that may enhance their personal investment into survival or reproduction. Choice of mates that minimize the risk of parasite or disease transmission should play a large role in female decisions. Male mating behaviors attempt to maximize their fitness through increasing their likelihood to mate with females they encounter. The wolf spider *Rabidosa punctulata* is a cursorial species, which brings it into contact with a common soil-dwelling arthropod pathogen, *Pseudomonas aeruginosa*, commonly causing internal infections that initiate costly immune responses. We artificially infected males with *P. aeruginosa* by inoculating their exoskeleton and subsequently investigated its effects on both female and male mating behaviors. The application of bacteria did not increase overall external bacterial load or internal infection load in males. Mating behaviors of neither the females (mate choice or time spent in association) nor the males (mating tactic expression) were influenced by male our male infection treatment. Investigation into any potential transfer of bacteria to females suggested no female costs of this association as females in both the treatment and control had similar external bacterial loads. Overall, this suggests that bacterial infections, both external and internal, may not be a driving source of selection on this wolf spider mating system.

**Keywords:** *Rabidosa punctulata*, *Pseudomonas aeruginosa*, *Mate choice*, *Infection*

## Volatile compounds in wine before and after imbibition

Alexis Lynn

*Flavor* is created in a person's brain as an image combining their senses of *taste* and *smell*. The sense of smell detects volatile chemical compounds that reach the neurons in the nasal cavity. These volatile compounds can be inhaled through the nose (*orthonasal smell*), or they can be exhaled from the mouth, throat and trachea (*retronasal smell*). With regard to sensing the flavor of wine, I hypothesize that, while the wine is warmed in the mouth to 37°C and interacting with both salivary enzymes and the oral microbiome, the wine and its volatile compounds will be chemically altered so that the retronasal smell of the wine will be different than its orthonasal smell. In this research, volatile compounds from wine samples and samples of exhaled breath pre- and post-imbibition were measured gas chromatographically (F.I.D.) to detect new compounds in the exhaled post-imbibition samples relative to the wine samples and the exhaled pre-imbibition samples. Multiple new compounds were detected. This research supports the hypothesis that the retronasal smell of wine is an important contributor to its perceived flavor.

**Keywords:** *volatile, orthonasal, retronasal, gas chromatography, wine, flavor, aroma, taste, imbibition*

# **The antibacterial activity of essential oils from *Tagetes erecta* and *Thuja occidentalis***

**Samantha Nelson**

Plants produce phytochemicals that have potential medicinal benefits. Essential oils are phytochemicals that have been recognized to have antibacterial properties. Bacteria are becoming resistant to current therapeutic agents. New methods need to be developed to help protect livestock, crops, and people from harmful bacteria such as *Staphylococcus aureus* and *Escherichia coli*. This study utilized steam distillation to extract essential oils from the leaves, stems, and flowers of *Tagetes erecta* and the branches and needles of *Thuja occidentalis*. The essential oils collected were studied for their antibacterial activity against *Staphylococcus aureus* and *Escherichia coli* using the disc diffusion method. These bacteria were utilized, because these are bacteria that are commonly associated with disease and spoilage in crops, livestock, and people. It was also important that a gram-negative and gram-positive bacterium was studied. Both *Tagetes erecta* and *Thuja occidentalis* essential oils showed antibacterial activity. An analysis of the compounds was done using GC-MS. The major components of *Tagetes erecta* essential oil were d-limonene, dihydrotagetone, piperitone, piperitenone, and caryophyllene oxide. *Thuja occidentalis* essential oil had alpha-pinene, 3-carene, and alpha-cedrol as its major components.

**Keywords:** Antibacterial, essential oil, natural product, phytochemicals, therapeutic agent

# **The effect of variable environments on aggressive behavior in *Betta splendens***

**Cameron Oram**

Sixteen adult *Betta splendens* were tested for aggressive behaviors based on environmental changes. Two groups of eight fish were assigned for the function of a paired t-test. The two groups experienced both treatments of control and variability then tested after each treatment. The procedure used was focused on the already natural aggression *Betta splendens* have. Placing a mirror in the tank for a duration of fifteen minutes with observation triggers this aggressive behavior. An ethogram was made to make observational characteristics measurable and quantitative during this mirror observational period. The results found to be inconclusive in correlating the variable environments and aggressive behavior. The action of changing the structural environment within each tank comparatively to the same fish being in a controlled structural environment does not change aggressive behavior.

**Keywords:** *Behavioral Science, Environmental Science, Betta splendens, Ethogram, Siamese Fighting Fish*

# **How long after a carrion beetle feeds on a beef carcass can you recover identifiable beef specific DNA?**

**Trenton Smith**

Carrion beetles are a main species that help in the decay of dead organisms and are a key species used by forensic entomologist to determine how long a body has possibly been deceased. We believe these beetles may offer even further insight into what happen on a crime scene based off their diet. Their diet can be used for DNA recovery of a specific species creating another DNA recovery method for crime labs. For this study we set up 5 different treatments with 5 samples for 4 of the treatments ( $n=50/\text{treatment}$ , 10 beetles/sample) with one treatment being just a meat sample. Beetles were given beef to feed on for 3 days and then the beef was removed. The 4 treatments after 1, 24, 48, and 72 hours away from the beef were each then separated into 5 samples. We chose these time periods to see how DNA may degrade over time and not be recoverable because of digestion. Extraction and purification of DNA from each sample was then started by Qiagen DNeasy purification kit. Once extracted and purified the DNA samples then went through PCR amplification and gel electrophoresis using Desert Hedgehog forward and reverse primers. Desert hedgehog is a mammalian specific primer used for many vertebrate and invertebrate studies. Major findings of the research conclude that 16 of the 21 samples ran through PCR were amplified showing that there is no degradation of beef DNA within 3 days of being removed from the scene. This result makes beetles a reliable source for DNA recovery.

***Keywords:*** *Desert Hedgehog primer, PCR amplification, Gel electrophoresis*

# **DNA Fingerprinting**

## **Devrie Sombers**

The two main uses of DNA fingerprinting today are for paternity tests and as evidence in a crime. DNA finger printing is a technique used to determine biological relatedness. In this study I obtained DNA from a family consisting of a mother, a father, and two sisters. DNA was also obtained from a possible half-brother, and a random sample of DNA from someone not related. DNA was extracted from saliva samples provided from each of the six participants. The DNA was then amplified through PCR using 10 of the CODIS loci. Gel electrophoresis was used to investigate variability in short tandem repeat regions. The different band patterns from each individual is what makes your DNA fingerprint unique to you. Based off of the bands that didn't appear after analyzing the gel sample under UV light, the experiment was inconclusive. A list of possible explanations for the lack of results are explained in the discussion.

***Keywords:*** *DNA fingerprinting, STR, PCR*

# **Weight Lifting Affects the EMG Activity of the Flexors and Extensors of the Legs**

**Kaitlynn Usdansky**

Athletes work out to become stronger and more flexible; these are two variables that can place their skill level over that of their competitor. By lifting weights athletes tear small muscle fibers that then repair themselves later, post workout, allowing them to grow, increase muscle capacity, and become stronger. The purpose of this study was to compare the Electromyography (EMG) activity of the flexors and extensors of the legs of female collegiate softball players before and after an 8-week weightlifting program, while the athletes also participate in daily practices, cardio, and games. Nineteen players from the McPherson College softball team completed the study. EMG measurements were taken on three separate dates while each subject did a series of three body squats. EMG absolute integrals and maximum peak data from the Gluteus Maximus, Biceps Femoris, Vastus Lateralis, and Vastus Medialis were compared from the first initial squat before participating in exercise and after weight lifting on a specified program for eight weeks. After analyzing the data, a significant difference was found in overall muscle activity, maximum peaks, and strength gain over the eight week time period. EMG absolute integral was found to be significantly lower in the anterior and posterior muscles of the right leg (Anterior:  $p=1.20824E-09$ ; Posterior:  $p=5.1024E-09$ ) after the eight week program. Maximum peak values were found to be significantly higher in the anterior and posterior muscles of the right leg (Anterior:  $p=1.03608E-06$ ; Posterior:  $p=5.92521E-05$ ) after the eight week program. Strength gain in back squat was also found to be significantly higher ( $p=3.2852E-07$ ) after the eight week program. With the assigned weight program, the subjects had less muscle activity while gaining leg strength by the end of the study.

**Keywords:**

# **Measuring the Relationship Between Body Condition and Body Composition in Two Kansas Spider Species**

**Parkes Wolters**

Energy is stored by organisms in one of three forms: proteins, carbohydrates, or lipids. This energy is used to perform the actions necessary for an organism to survive. An individual's body condition is a summary accounting for both the ability to acquire resources and properly allocate them. Ecologists use a variety of indices to estimate the body condition of an organism. In this study, two species of Kansas spider were caught in the wild and analyzed for body composition and body condition. These spiders have two distinct foraging types; one being a web-builder, *Neoscona crucifera*, and the second a ground/active hunter, *Rabidosa punctulata*. The body composition of these spiders differed as might be expected with two very different foraging styles. *N. crucifera* contained a higher fat content, and *R. punctulata* contained a higher percent protein and water weight by mass. The only significant relationship between a body condition index and a measure of any energy macromolecule was found between lipid percentage and the body condition residuals in *R. punctulata*.

**Keywords:** *Body condition, fitness, macromolecules.*

# **The affects of hydrocarbon contamination on the soil microbial consortia from Quivira National Wildlife Refuge**

**Soren Yarnall**

Three soil samples were collected. Two samples from the Quivira Wildlife Refuge in Kansas. One of the samples was contaminated with oil and the other was from a salt marsh. The third sample was of fresh water from McPherson Kansas. The samples then went through a metagenomic shotgun sequencing which gave an in depth analysis of the microbiomes within the soil samples. The sequencing broke down the different make-ups of the bacteria ranging from the gene production and abundance analysis to the antibiotic resistance. Each of the three samples showed to share a few similar genes but the majority was different. Overall they showed to be different from each other with the different types of bacteria. The most common type of bacteria found within the samples was proteobacteria. There was not a big correlation between each of the three samples that were taken.

***Keywords:*** *hydrocarbon contamination; microbiomes; proteobacteria; antibiotics*

# Natural Science Research Awards

Awards are bestowed on students who demonstrate excellence in research. The highest honor, the **Burkholder Research Award**, honors outstanding achievement. The **Merit Research Award** distinguishes significant achievement. For each award, the Natural Sciences faculty selects one or more candidates based on three criteria: 1) selection and design of a senior research project; 2) quality of the research, including technique, observations, and data analysis; and 3) presentation of the research, comprising preparation of a scientific research paper and an oral presentation to students and faculty. A Certificate is granted to each winner. Persons qualifying for the Burkholder Research Award have their name inscribed on a plaque and receive a year membership in the American Association for the Advancement of Science and a subscription to *Science*.

Year	Burkholder Award	Merit Award
2018		
2017	Nathan Finch	Nora Grosbach, Amy Makovec
2016	Tiffany Fraser, Ashley Long	Sheryl Evans, Lucas Giese
2015	Nathaniel Schowegerdt	Alia Khalidi, Kaley Kinnamon
2014	Yi Qun Chai, Sean DeYoung	Shannon Coldren, Sydney Lipton, Jordan Stewart
		Lori Crain, Alejandro Esparza, Christian Rodriguez
2013	Amanda Baxter, Emily James	Torey Fry, Kasey Miller
	Taylor Roop	
2012	Audrey McTaggart	Savannah Sievers, Andrew Skinner
2011		Karissa Ferrell, Kelley Green,
		Ashley Zodrow
2010	Ashlee Jost, David Miller	
2009	Adam Horinek	Amanda Pangburn, Nicole Sampson,
2008	Joel Grosbach, Landon Snell, W.	Lezli Warkentin
	Brett Whitenack	Alan Grosbach
2007	Callie Crist	Rhonda Hoffert, Jamie Rodriguez
2006	Travis Allen	Lisa Sader
2005	Joseph Blas	David Cockriel, Jenny Harper, Danielle Lucore
2004	Robert Ullom	
2003	Michelle Schulz	Adeline Cripe
2002	Elizabeth Stover	Renata Lichty
2001	Genelle Wine	Jonas Lichty
2000	Nathan McLaughlin	Jeffrey McPherson
1999	Roy Johnson, Jr.	Jennifer M. Amiot, Janet Bowen, Eric D. Putnam,
		Anna Katharina Schenk
1998		Rebecca Standafer, Cameron Mahler
1997	Kerri Kobbeman	Rod Samuelson
1996		Stasi Zirkel, Wes Sechler, Chris Owens
1995	Heather Hughbanks, Monica Embers	Erik Harmon
1994	Adam Smith	Paula Worley, Adeola Grillo, Sherry Coopple,
		Susan Blubaugh
1993	Tyson Burden	Robin Morgan
1992	Pete Hanson	
1991		Shannon Hull, Thomas Champion
1990	James Dechand	David Maxey
1989		Michelle Roesch
1988	David Lehmen	Sandra Ashbaugh, Cynthia Aeschacher
1987	Marla Ullom, David Krehbiel	Jay Nicholson, Marsha Morley,
		Cassandra Clark