4-2021

PROGRAM, THE NEBRASKA ACADEMY OF SCIENCES: One Hundred-Thirty-First Annual Meeting, APRIL 23-24, 2021. ONLINE

THE NEBRASKA ACADEMY OF SCIENCES, INC.

PROGRAM

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One Hundred-Thirty-First Annual Meeting

APRIL 23-24, 2021 | ONLINE

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THE NEBRASKA ACADEMY OF SCIENCES, INC.

302 Morrill Hall, 14th & U Street, Lincoln, Nebraska 68588-0339

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GENERAL INFORMATION

The Nebraska Academy of Sciences was organized on January 30, 1880, with monthly scheduled meetings in Omaha, Nebraska. The Academy was reorganized on January 1, 1891, and annual meetings have been held thereafter.

AUTHORS ARE INVITED TO SUBMIT MANUSCRIPTS OF THEIR WORK FOR PUBLICATION IN THE *TRANSACTIONS* OF THE NEBRASKA ACADEMY OF SCIENCES, a technical journal published periodically by the Academy.

Articles in all areas of science, science education, and history of science are welcomed, including results of original research as well as reviews and syntheses of knowledge.

The *Transactions* has moved to a digital format and is available to anyone through the Digital Commons at the University of Nebraska–Lincoln. It is abstracted by major abstracting services as well. Manuscripts should be submitted via the online submission system at http://digitalcommons.unl.edu/tnas/guidelines.html using the 'Submit your paper or article' link.

ZOOM HOME ROOM

If you need technical assistance during the Nebraska Academy of Sciences meeting or would like to chat with other attendees in a Zoom breakout room, please visit https://unl.zoom.us/j/95704187828 between 7:45 a.m. and 5 p.m. Central Time on April 23 and 7:45 a.m. to 12:30 p.m. on April 24.

Zoom and conference logistical support provided by the:

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Web site: http://sections.maa.org/nesesd/

11. **Nebraska Space Grant Consortium**
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University of Nebraska at Omaha

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Nebraska Academy of Sciences (all members)
State of the Academy
Awards Ceremony
Vote by NAS members on Revisions to NAS Constitution
Comments from Members-at-Large

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REVIEW OF PASSIVE AND NON-PASSIVE PHYSIOLOGICAL MONITORING TECHNOLOGY FOR LONG-TERM SPACEFLIGHT

Stephanie Vavra and Shane Farritor, Department of Mechanical and Materials Engineering, University of Nebraska-Lincoln, Lincoln, NE 68588; Baraquiel Reyna, NASA Johnson Space Center, Houston, TX 77058

Physiological monitoring of astronauts during space exploration has been important since the first human flight. The National Aeronautics and Space Administration (NASA) routinely monitors and records astronaut vital signs to reduce medical risk during all near-earthorbit (NEO) missions. However, as NASA prepares for longer missions in a return to the moonand to planets such as Mars, more challenges arise in the monitoring of astronaut vital signs. Most past technologies require physical contact with the astronaut, which can be inconvenient and require significant on-flight set-up and maintenance and therefore limit the amount of monitoring. Thus, there is an increasing demand for non-intrusive, passive technologies that require little operational intervention. Fortunately, non-intrusive health monitoring technologiesare becoming increasingly popular and are being developed by the private sector for terrestrial applications. This research reviews state-of-the-art non-passive physiological monitoring technologies as well as emerging passive physiological monitoring technologies and the potential use of these technologies in long-duration space missions. Vital sign technologies thatmeasure heart rate, blood pressure, oxygen saturation, respiratory rate, body temperature, and intraocular pressure are investigated in this research and evaluated based on their suitability for spaceflight.

VISUAL CONTRIBUTIONS TO BALANCE CONTROL DURING GAIT

Stephanie Mace and Mukul Mukherjee, Department of Biomechanics, University of Nebraska at Omaha, Omaha, NE 68123

In addition to the physical aspects that affect astronauts in space, there is also a visual aspect that could potentially be affected during and post space flight. While in space, astronauts face a microgravity environment that can affect the visual and associated sensory systems. Thereis also a change of the interaction between the astronaut and their environment. For example, when you are in space, you are unstable and bouncing from place to place. This instability in locomotion and deficits in visual feedback can possibly impact visual-based decisions that are not faced while you are on earth. Additionally, when astronauts wear their space suits, there is alimitation to their visual field and ability to use their proprioceptive system to help them give additional information about their environment that they are interacting with. Therefore, sensorimotor interactions in space is significantly different from that on Earth with critical implications on space travel and space research. Specific to the visual system, there is a currentlack of knowledge on how a dynamic visual environment affects the sensorimotor system. Exploring this realm would allow us to not only rehabilitate astronauts following space flight, butit would also present the opportunity of training astronauts before and during spaceflight in hopesof limiting any visual deficits that occur during their time in space. In order to begin understanding the effects of an unstable environment to the visual processing system while interacting with a dynamic visual environment, we are utilizing the CAREN system which is a treadmill on a platform that is on a flight simulator with a 180-degree immersive virtual reality. The CAREN system will provide perturbations to the

individual while they are walking at variousspeeds in addition to the walking platform rotating in the yaw direction (twisting a bottle cap). Additionally, the optic flow projected onto the screen will have a varying point of emergence thatthe individual will have to determine if it is aligned with them or not. The objective is to challenge conventional tests of dynamic visual acuity and examine a novel test that may be moresensitive to the type of visual processing required in environments commonly encountered by astronauts. The results of this research could provide an innovative method to assess in space, extra-terrestrial and post-flight performance of tasks and in the long term provide countermeasures that improve visual processing in those environments.

DISRUPTING INTER-LIMB COORDINATION THROUGH AN EXOSKELETON DEVICE

Takashi Sado and Mukul Mukherjee, Department of Biomechanics, University of Nebraska at Omaha, Omaha, NE 68182

Healthy gait requires the two legs to be working in smooth and efficient coordination. However, space travel, and time spent in micro- or macro-gravity can cause disruptions in the efficiency of such coordination during walking. Traditionally, inter-limb coordination has been examined using linear analyses, but these are limited in capturing the dynamics of human movements. Specifically, nonlinear analytical tools like Cross-Recurrence Quantification Analysis (cRQA) and Cross-Sample Entropy (cSE), can characterize how human inter-limb coordination evolves over time. Therefore, in this study, we examined the temporal structure of inter-limb coordination, specifically how long the two legs were coordinated and how repeatable were their gait patterns. We did this by making healthy human participants walk naturally and the disrupted their inter-limb coordination by using a passive exoskeleton device which providedspring-loaded assistance during swing. Healthy young participants were assigned to either a unilateral exoskeleton group (EXO) or a control group. All participants performed normal walking at their preferred speed. Inter-limb coordination was examined using nonlinear tools, specifically, cRQAand cSE of heel marker kinematics in the sagittal anterior-posterior direction.The results from cRQA showed that although the duration of coordination was shorter and largerphase space was needed in the EXO group, the predictability of inter-limb coordination did notdiffer between the groups. Higher cSE values in the EXO group indicated that walking with thedevice decreased the repeatability of the inter-limb coupling. An unpowered exoskeletal device altered inter-limb coordination by reducing its duration and repeatability. In individuals who have altered inter-limb coordination patterns such as patients with sensorimotor deficits or astronauts in altered gravity environments, such devices could be used to drive inter-limb coordination in specific directions to restore health.

RESILIENCY, RESERVE, AND FATIGABILITY; INSIGHTS INTO FALL RISK

Alissa Miller, Hyeon Jung Kim, and Jennifer Yentes, Department of Biomechanics, University of Nebraska at Omaha, Omaha, NE 68182

Upon return to earth, an astronaut's physical resiliency—defined as the ability to resist or recover from a disturbance to one's balance—is noticeably decreased due to muscle deterioration and bone density loss. An astronaut's ability to recover from a balance disruption is dependent on the difference between a system's basal level and its maximum capacity to react.The purpose of this study was to measure baseline levels of balance and then determine the maximal threshold

capacity cannot be recovered (i.e. a fall). Sixteen middle aged subjects completed a balance assessment with five different levels of disturbance to their balance. Theircontrol of balance was measured as the range of movement, or sway, in the forward/backward direction. Out of these 16,only 4 lost their balance and are considered for the analysis (62.5±2.4yrs). The mean basal range of movement was 19.1±4.4 mm. The maximal threshold capacity wascalculated as the basal level range minus the range at the greatest disturbance without falling. The threshold capacity ranged from 57.7 to 124.2 mm. Our preliminary data suggest a range inwhich to aim for balance disturbance training astronauts so as to meet a "normal" balance capacity following space flight.

IMPACTS OF GROUP III/IV AFFERENT ACTIVATION DURING PROLONGED SITTING WITH MILD HYPERCAPNIA ON CARDIOVASCULAR FUNCTION IN HEALTHY ADULTS

Elizabeth J. Pekas, TeSean K. Wooden, Michael F. Allen, Cody P. Anderson and Song-Young Park, School of Health & Kinesiology, University of Nebraska at Omaha, Omaha, NE 68182

It is well accepted that prolonged sitting impairs peripheral vascular function, which often occurs in enclosed spaces with mild hypercapnic atmospheres. We have previously confirmed the negative effects of prolonged sitting and found those effects were exacerbated with the addition of mild hypercapnia. Previous literature has attempted to reverse the detrimental effects of prolonged sitting with activity breaks, including short periods of walking and fidgeting, but no group has investigated the mechanism of Group III muscle afferent activation during those activity breaks on vascular function. Therefore, we sought to determine the impacts of Group III muscle afferent activation (by passive leg movement) in healthy adults during prolonged sitting with mild hypercapnia. Healthy young adults (n = 14) participated in two experimental visits that consisted of sitting for 2.5 h in a control hypercapnic condition with no leg movement (CO_2 =1500 ppm, CON) and sitting for 2.5 h in a hypercapnic condition with passive leg movement (CO_2 =1500 ppm, PASS) in a randomized crossover design. At both visits, measures of blood pressure (BP), brachial and popliteal artery endothelial function (flow- mediated dilation, FMD), arterial stiffness(pulse-wave velocity, PWV), augmentation index (AIx), heart rate variability (HRV) and skeletal muscle oxygen utility were taken before and after sitting. Significant group by time interactions ($p<0.05$) for reduced deoxygenated hemoglobin and improved total tissue saturation index after passive movement during prolonged sitting. Significant time effects ($p<0.05$) in sympathetic output, brachial FMD, and popliteal FMD were noted. These results indicate that group III muscle afferent activation may help maintain autonomic function and microvascular function during prolonged sitting in healthy adults in mild hypercapnic conditions.

PROFESSIONAL DEVELOPMENT FOR UNDERGRADUATE FEMALE ENGINEERING STUDENTS: A CASE STUDY ON CONFERENCE PARTICIPATION DURING A PANDEMIC

Christine E. Wittich, Department of Civil and Environmental Engineering, University of Nebraska-Lincoln, Lincoln, NE 68588

According to the National Center for Science and Engineering Statistics at the National Science Foundation, the total number of bachelor's degrees in Engineering annually awarded in the United States has nearly doubled over the past 20 years. Despite this increase in the total

number of degrees awarded, the percentage of degrees awarded to women has not increased and remains well below that of men in all fields of engineering, particularly in aerospace, electrical,and mechanical engineering. The Society of Women Engineers (SWE) is a national organizationwhose mission is to "stimulate women to achieve full potential in careers as engineers and leaders, to expand the image of the engineering profession as a positive force in improving quality of life, and to demonstrate the value of diversity." Executive officers and members of thestudent chapter of SWE at the University of Nebraska-Lincoln participated in a nationalconference for women engineers in Fall 2019 (in-person) and in Fall 2020 (virtually due to travel restrictions). Programming at the conference included career management, inclusion and cultural awareness, innovation and disruption, self-management and development, and strategic leadership. While some of the student participants had previously attended professional or academic conferences, the students noted substantial gains from the targeted professional development offered at this type of conference. However, there are noted discrepancies considering the in-person versus virtual conference offerings in terms of student gains. Studenttravel was sponsored, in part, by NASA Nebraska Space Grant.

THE ELEMENTARY OUTREACH PROGRAM

Chloe Jensen, Aly Anderson and Dr. Jennifer Grove, Science Department, College of Saint Mary, Omaha, NE 68106

The College of Saint Mary (CSM) Elementary Outreach Program provides hands-on activities and interactive learning in math and science topics to elementary students (grades K-5) in the Omaha and surrounding areas. This service is provided by CSM students who work ingroups to teach the lessons according to Nebraska state science standards, as well as incorporating a fun, hands-on activity to demonstrate and enforce the material. The program works to reach as many students in the Omaha community as possible each year, as well as utilizestudent volunteers from all majors and backgrounds at CSM. The program has been found to promote a growing career path, interest in the STEM subjects, and a chance to spark new interests in elementary students. Many area elementary schools do not have the resources to incorporate such activities and this program allows children to experience projects that they can often take home and continue researching. Due to the COVID-19 pandemic, the use ofvolunteers at schools was cut and the program had to improvise. The goal was to still provide hands on activities to students from a virtual level. So, the Co-coordinators as well as other staff and faculty members came together to create educational, fun, and interactive videos for studentsto watch at home or in the classroom. Through this project, previous activities have been transformed to videos that allow students to still understand the topic, review with a worksheet,and find everyday items at home to perform a small hands-on activity. Reviews from students, teachers, and schools have all been positive and supportive of the idea.

MOTOR DEXTERITY, MOTOR CORTEX HEMODYNAMIC ACTIVITY, AND BEHAVIOR IN CHILDREN AFTER ISOLATION

Kaitlin Fraser and Jorge M. Zuniga, Department of Biomechanics, University of Nebraska at Omaha, Omaha, NE 68182

Many children undergo periods of isolation while they are going through prolonged hospitalization. These children encounter limited face-to-face interactions while they are

undergoing some medical treatments, and some children face periods of isolation multiple times through their lives. This study is designed to assess the impact of isolation on their gross manual dexterity, cognitive functioning, behavior, and socialization. This information can lead to insights into how humans develop and refine these skills. While these children often undergo isolation for relatively short periods of time, they are facing this isolation during periods of development. Accordingly, this experiment was designed to determine differences in theprimary motor cortex activity, gross manual dexterity, communication skills, and socialization between children experiencing isolation due to prolonged hospitalization compared to typicallydeveloping children. We predict that the children who have recently undergone isolation due to prolonged hospitalization will result in increased and less localized motor cortex activity, as well as lower gross manual dexterity than typically developing children due to their decreased exposure to a variety of play experiences. We anticipate enrolling children (n=60) between 3 and18 years of age separated in 4 different age groups (3 to 6, 7 to 9 and 10 to 12, and 13-18 years ofage). Two groups of children will be recruited; children experiencing isolation due to immunosuppression, cancer treatment, or prolonged hospitalization (n=30) and an age- and sex-matched control group of typically developing children who have not been hospitalized (n=30).Both groups will perform a gross manual dexterity task while measuring cortical brain activity, as well as completing behavioral assessments. Manual hand gross dexterity will be assessed using the Box and Blocks Test. Participants will conduct three trials of the Box and Blocks Teston each hand while wearing an fNIRS cap to assess motor cortex activation patterns. The Behavior Assessment for Children, Third Edition will also be completed. Analyses will examinethe differences between the groups, within the groups, and will examine outcomes related to length of isolation. The results from this research can be used to direct future research into the impacts following isolation in astronauts after space travel.

INVESTIGATING VARIABLE ACCRETION RATES IN QUASARS BY COMPARING OPTICAL VARIABILITY DATA WITH ACCRETION DISK SIMULATIONS

Alan Roden, Dr. Jack Gabel and Shrey Ansh, Department of Physics, Creighton University, Omaha, NE 68102

Quasars, which are found in the centers of supermassive black holes, are extremely luminous and can shine up to 100,000 times brighter than the Milky Way. Quasars are surrounded by large accretion disks made up of mostly gas particles, and this serves as the enginefor a quasar. However, what is partly a mystery to this point is what exactly the process is by which energy is released in the accretion disk, which is the main goal of this research project. The project will attempt to accomplish this with two parts: 1) analyze data from several quasardatabases, including the Sloan Digital Sky Survey (SDSS) and 2) use an existing simulation thatmodels emission variability in accretion disks and expand on it to include the emission at a larger range of wavelengths. The data that will be used was collected from all five of the optical bands,which was captured by the SDSS Stripe 82. Then, the taking of the known data and attempting to match the data with the simulation will assist in explaining the data that was collected. The advantage of a simulation that matches the observed data is that this allows for manipulating thesimulation and determining the constraints that cause the simulation to match the data, which then allows for conclusions to be made about the actual phenomenon that the simulation mimics.The simulation that is being used utilizes a radius dependence, as well as an Auto-Regressive, AR(1), process. The AR(1) process regresses on its previous value, and then adds randomness into the next value.

The hope is that this process simulates the infalling material that is spiraling around the supermassive black hole in that the regressing on the previous value simulates the material that is further out in the accretion disk, and the randomness term mimics the stochastic (random) nature of quasars. By combining the two results from both parts of this project, the hope is that the constraints on the accretion process at different locations of the accretion disk will be found and that conclusions about the accretion mechanism, which is the end goal, can be made.

TESTING ACCRETION DISK WIND MODELS FOR QUASAR MASS OUTFLOW PROFILES

Jeffrey Brozek and Jack Gabel, Department of Physics, Creighton University, Omaha, NE 68178

Quasars are some of the most extreme objects in the universe. They have a supermassive black hole millions to billions of times the mass of the sun, surrounded by a solar system sized disk of gas that's so hot it outshines an entire galaxy. Approximately 20% of quasars exhibit high velocity mass outflows as seen in blue-shifted absorption in the UV spectra. The UV spectraof quasars have broad, blue-shifted absorption lines, referred to as Broad Absorption Lines (BAL). These BAL indicate that there is high energy mass outflow from the quasar. The Accretion Disk Wind model predicts that these outflows are radiationally driven off the accretion disk and is the leading model for BAL. The physical conditions of the BAL outflowing gas are the result of photoionization by the central source. We present a novel analysis of the radiation driven Accretion Disk Wind model for BAL by using a photoionization modeling application called CLOUDY. We vary the physical parameters within Cloudy models to produce ionic column densities that are compared with observations and simulations of the outflows.

DIRECT DETECTION OF COUPLED PROTON AND ELECTRON TRANSFERS IN HUMAN MANGANESE SUPEROXIDE DISMUTASE

Jahaun Azadmanesh and William Lutz, Eppley Institute for Research in Cancer and Allied Disease, Gloria Borgstahl, Eppley Institute for Research in Cancer and Allied Disease, University of Nebraska Medical Center, Omaha, NE, 68135, Leighton Coates, Second Target Station, Oak Ridge National Laboratory, Oak Ridge TN, 37831, Kevin Weiss, Neutron Scattering Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831

Oxidoreductases are a class of enzymes that perform electron transfers and represent over a quarter of known enzymes. Many oxidoreductases are integral to human vitality though most of their mechanisms are unclear due to the difficulty in observing the protons that are usedas chemical tools to drive the electrons transfers in a process called concerted proton-electron transfer (CPET). Human mitochondrial manganese superoxide dismutase (MnSOD) is a prominently studied oxidoreductase in clinical research due to its central role in the oxidative stress response. MnSOD uses cyclic CPET reactions to convert superoxide ($O_2^{\bullet-}$) into either oxygen (O_2) or hydrogen peroxide (H_2O_2), depending on the oxidation state of the metal and theprotonation statusof the active site. Like many other oxidoreductases, the protonation states andproton transfers (PTs) needed to facilitate redox reactions are unknown. Here, neutron diffraction of two redox-controlled manganese superoxide dismutase crystals reveal the all- atom structures of Mn^{3+} and Mn^{2+} enzyme forms. The structures deliver direct data on protonation changes between oxidation

states of the metal. Observations include glutamine deprotonation, the involvement of tyrosine and histidine with altered pK_as, and four unusual short-strong hydrogen bonds, including a low barrier hydrogen bond. We report a concerted proton and electron transfer mechanism for human manganese superoxide dismutase from the direct visualization of active site protons in Mn^{3+} and Mn^{2+} redox states.

CALCIUM CARBONATE AS A POTENTIAL CARBON SOURCE FOR METHANOGENESIS IN THE MARTIAN SUBSURFACE

Nicole A. Fiore, Sanjay Antony-Babu, Rebecca V. Kiat, Donald Pan, Caitlin Lahey and Karrie A. Weber, School of Biological Sciences, and Nicole R. Buan, Department of Biochemistry, University of Nebraska-Lincoln, Lincoln, NE 68588; Rebecca A. Daly and Kelly C. Wrighton, Department of Soil and Crop Sciences, Colorado State University, Fort Collins, CO 80523; Daniel N. Miller, Agricultural Research Service, United States Department of Agriculture, Lincoln, NE 68588

It is estimated that approximately 70% of all microbial life on Earth resides in the subsurface. The Martian subsurface may likewise be (or may once have been) hospitable to microbial life, offering protection from surface radiation and temperature extremes. One consequence of a subterranean Martian biosphere however, is isolation from the atmosphere and gaseous CO_2, a significant source of the carbon required for life. An alternative carbon source might be solid-phase inorganic carbon-bearing minerals (e.g. carbonates), deposits of which have been identified in the Martian subsurface. Unfortunately, little is known about the potentialfor microbial carbonate dissolution, particularly under the alkaline pH conditions that are required for mineral stability. To investigate the viability of carbonate minerals as a carbon source for methanogens at alkaline pH, an anaerobic enrichment culture was initiated from alkaline saline wetland soil in minimal medium (100% argon, pH 8.3) with added hydrogen as an electron donor and calcium carbonate as the sole source of inorganic carbon. Geochemical data was recorded for triplicate live cultures relative to heat-killed and uninoculated controls. Increases in methane and cell number were measured over time in live cultures with observed decreases in headspace hydrogen gas. Dissolved calcium also increased in live cultures with nosignificant change in pH implying microbially catalyzed dissolution of the calcium carbonate mineral. Shotgunmetagenomic sequencing and genome assembly of the enrichment culture confirmed the presence of a methanogen (*Methanobacterium* sp.), alongside several othercommunity members includingan *Acetoanaerobium* sp., *Pseudomonas* sp., *Desulfovibrio* sp., and *Tessaracoccus* sp. Genomic data also confirm the *Methanobacterium* sp. has a complete pathway for hydrogenotrophic methanogenesis from bicarbonate. Together, these results suggestthat calcium carbonate can act as a carbon source and electron acceptor for methanogens whencarbon is limiting, and that carbonate mineral fixation is sufficient not only for methanogenic growth, but also to maintain a metabolically diverse microbial community. Carbonate deposits together with radiolytically generated H_2 therefore have the potential to sustain past or present methanogenic microbial life inthe Martian subsurface.

EVALUATING *PYTHIUM* GROWTH-LIMITING FACTORS IN THE HYDROPONIC SUPPORT SUBSTRATE, PEAT MOSS

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Pythium ultimum, a plant pathogen that causes root rot, is a particular problem in hydroponic systems. Support substrates, including peat moss, are used in hydroponics to anchor plants. These substrates, if contaminated with a pathogen, can serve as a source of inoculum to the plants. Several substrates, inoculated with *P. ultimum,* supported the pathogen for many months. However, peat moss seemed to inhibit *P. ultimum* 2-4 weeks afterinoculation. Peat moss has a low pH, but experiments modifying pH indicated that acidity was not the inhibitory factor affecting *P. ultimum* growth. Furthermore, no water-soluble, inhibitory exudate from peat moss was found. Our next step is to evaluate the role of moisturereretention by peat moss in supporting or inhibiting *P. ultimum*.

IDENTIFICATION OF MUTATIONS IN PSEUDOMONAS AERUGINOSA STRAINS THAT ARE HIGHLY RESISTANT TO A NOVEL ANTIMICROBIALPEPTIDE BY GENOME SEQUENCING

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There is an urgent need for alternatives to traditional antibiotics due to the proliferationof multi-drug resistant strains of pathogenic bacteria. Antimicrobial peptides (AMPs) are a promising alternative to current options. DASamP2, a novel AMP developed by the Wang lab atUNMC, is highly effective at killing *Pseudomonas aeruginosa* and *Staphylococcus aureus*. However, both the mechanism of action and how resistance to this peptide might evolve are currently unknown. To gain insights into this we generated P. aeruginosa mutants using transposon mutagenesis and isolated strains with significantly increased resistance to DASamP2. Studies of one of the most resistant mutants indicated it had altered sensitivity to other antibiotics and RNA sequencing revealed dramatically altered gene expression. Genetic studies of the two most resistant mutants suggested both strains contain mutations affecting AMP sensitivity other than the randomly inserted transposon. Therefore, we sequenced the whole genome of both mutants using next-generation sequencing. With alignment to the PAO1reference and *de novo* assembly completed, our current focus is the analysis of all identified variants found in the two genomes. Our next set of experiments will focus on mutations most likely to be affecting resistance to AMPs and then determine which are necessary and sufficientto explain altered sensitivity to DASamP2.

TESTING FOSFOMYCIN RESISTANCE USING A N- ACETYLGLUCOSAMINE-MALATE (GLCNAC-MAL) INHIBITOR IN *BACILLUS SUBTILIS*

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Pathogens are becoming more resistant to antibiotics and the production of new treatments has been declining. The Gram-positive bacteria methicillin resistant *Staphylococcusaureus* (MRSA) is a leading cause of bacterial infections seen in hospitals due to specific enzymes that alter the structure and function of employable antibiotics. The FosB enzyme is a Mn (II) dependent thiol transferase found in *S. aureus*. FosB catalyzes thea S_N2 nucleophilic reaction altering the structure of Fosfomycin (an antibiotic) leading to a nonfunctional form. Bacillithiol, the main thiol substrate for FosB, also helps protect bacteria from external stressors. Previous studies have

indicated that bacterial strains that did not have bacillithiol or the FosB enzyme were more susceptible to the antibiotic fosfomycin. The objective of the study is to determine if the inhibitor N-acetylglucosamine-malate (GlcNAc-Mal), an intermediate of the bacillithiol pathway, can inhibit the FosB enzyme in Gram-positive bacteria. The hypothesis is that GlcNAc-Mal will inhibit the FosB enzyme through competitive inhibition, which will be seen through larger zones of inhibition. Disk diffusion assays involving wild-type *Bacillus subtilis*, 10-100 µg of Fosfomycin, and 0.5-8 mmol GlcNAc-mal showed increased sensitivity to Fosfomycin. Larger zones of inhibition were seen when GlcNAc-Mal was paired with high concentrations of fosfomycin (100 µg) in wild- type *B. subtilis.* Bacteria were only considered susceptible to the combination treatment whenpaired with 100 µg fosfomycin. GlcNAc-Mal addition did not change the size of the zones of inhibition significantly when paired with fosfomycin. Assays that contained only GlcNAc- Mal and GlcNAc-Mal paired with lower concentration of fosfomcycin (10 µg) showed no zones of inhibition. The lack of correlation between GlcNAc-Mal concentration and zone size, and lack of zones of inhibition with low concentration of fosfomycin could be due to feedforward activation of the bacillithiol biosynthesis pathway by GlcNAc-Mal. Feedforward activation by GlcNAc-Mal causes an increased production of bacillithiol, which aids the FosBenzyme, leading to increased antibiotic resistance. Additional results involving disk diffusion assays with FosB, BshB, and BshA and BshB knockout *B. subtilis* cell lines are in the processof being collected. A two plasmid CRISPR/Cas9 system will be used to make the knockout cell lines. To date, research has illustrated that GlcNAc-Mal is an effective inhibitor of FosB *in vitro*, but *in vivo* data has not yet confirmed this activity. This information can be used to develop combination therapies to increase the efficacy of current antibiotic treatments for pathogens such as MRSA.

TOPOLOGICAL CELESTIAL NAVIGATION, SPACE NETWORKING, AND AFFINE VARIETIES

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Final contributions were made to the startracking project, born out of a project from the previous summer pathways internship with NASA's Glenn Research Center. This project produced two novel methods of determining a spacecraft's attitude. This work was presented atthe 2021 IEEE AeroConf in March. In addition, there was collaboration with a group of SUNYAlbany Math PhD students for a NASA grant to study Delay Tolerant Networking in Space. This included developing a possible project based on Tropical Geometry for a parallel path optimization algorithm that takes into account the sporadic nature of a space network. Lastly, anongoing seminar in Algebraic Geometry was created in the department in preparation for undergraduate students interested in the GRC Summer internship, specifically with the group Iwork in.

USING NONLINEAR VIBRATION ABSORBERS TO MITIGATE UNWANTED MOTION IN HIGH-ASPECT-RATIO WINGS

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For the aerospace industry to expand beyond its current market, longer flights must become more accessible and environmentally friendly. One approach to improving the stability and

endurance of airliners is the implementation of high-aspect-ratio wings (HAR). However, while HAR wings are more efficient than standard wings, they present their own problems because they introduce high-amplitude, low-frequency vibrations in the longitudinal direction inaddition to the transverse direction. This research investigates the effectiveness of nonlinear energy sinks (NESs) with two-dimensional motion for mitigating the vibrations of HAR wings in both the transverse and longitudinal direction simultaneously. A computational modelgenerated from a wind-tunnel model is used as verification of the HAR wing's natural frequencies. A reduced-order lumped parameter model with identical natural frequencies is constructed to study the effectiveness of the NESs under impulsive excitations. Two types of clearance nonlinearities are investigated: first, the NES is surrounded by a diamond and, second, the NES is surrounded by an ellipse. The effectiveness of the NESs is determined using the computational model first and these predictions are validated experimentally. Both the computational and experimental results show that the elliptical clearance nonlinearity results in better vibration absorption and mitigation for both transverse and longitudinal vibrations.

TRANSITION TO TURBULENCE AND THE DECAY OF TURBULENCE OVER SLIPSURFACES

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Turbulence is an emergent phenomenon which is ubiquitous throughout nature and engineered systems, alike. While turbulence is beneficial in some applications, like those requiring increased scalar mixing, it can be detrimental to the efficiency of systems by increasingthe skin-friction. It becomes imperative in certain applications, then, to have the ability to control, or alter, the onset of turbulence. In this talk, we discuss our current work to study how the onset of turbulence is altered by the inclusion of slip surfaces, or surfaces which facilitate anon-zero velocity at the solid-liquid interface, at the boundaries of a plane Poiseuille (channel)geometry. Previous studies have shown that slip surfaces do affect the transition to turbulence, but there is no strict consensus on whether they delay or induce transition. Therefore, in additionto statistical analysis on the effect of slip surfaces on transitional flow, we utilize exact coherentsolutions (ECSs) to the Navier-Stokes equations to perform more deterministic analysis on howtransition is altered with slip surfaces. Statistical analysis shows that turbulent flows are more likely to return to the laminar state as the degree of slip is increased. This suggests that slip surfaces have a stabilizing effect on the flow. Utilizing ECSs for a deterministic analysis showsthat slip surfaces affect transition in distinct manners depending on the flow structures that inducethe transition. For structures near the wall, slip surfaces delay the onset of transition, and, eventually, prevent transition altogether beyond a critical slip length. However, for structures near the center of the flow, transition is induced earlier with slip surfaces. Additionally, while much information can be gained from the study of transition from laminar flow to turbulent flow,there are important insights to be gained from studying the decay of a turbulent flow to the laminar state. Recent work (Liu etal. *J. Fluid Mech.*, vol. 915, A65) showed that spanwise velocity decays faster than the streamwise component when a turbulent flow is allowed to decayto a laminar state. Therefore, we investigate the effect of slip surfaces on this anisotropic decayof turbulence. Our results show that this anisotropy in the decay of turbulent energy is still present with the inclusion of slip surfaces and appears to cause a faster decay when compared with the no-slip case. Possible mechanisms and conclusions are discussed for the observed behavior.

EMBEDDING SILVER INTO ALUMINUM SURFACES USING FEMTOSECOND LASER SURFACE PROCESSING

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By utilizing a novel femtosecond laser surface processing technique, we demonstrate unique mixing of silver and aluminum in laser induced microscale surface structures. The structures consist of a thick layer of redeposited material that is a mix of submicron-scale silver particles and aluminum/aluminum oxide particles overlaid on alternating layers of aluminum/aluminum oxide and silver. Below the redeposited material is resolidified and unmodified layers of both metals. Subsurface analysis was completed with cross-sectioning of the surface structures using focused ion beam milling techniques and analysis using energy dispersive X-ray spectroscopy and scanning electron microscopy to determine the extent of the silver and aluminum mixing. The cross-sectional analysis also provides insight into how these dynamic structures form. The unique combination of these materials allows for easier tracking of material to study the major formation mechanisms for these microstructures, such as ablation,redeposition, and hydrodynamic melt flow. The primary motivation for embedding silver into microstructured aluminum surfaces is to produce antimicrobial properties. Not only is silver inherently antimicrobial, but aluminum oxide nanoparticles and microstructures on the same scale as the bacteria also have antimicrobial properties. These unique surfaces are targeted for applications that require frequent surface sterilization. Post-sterilization handling of spacecraft hardware for testing and re-work by NASA requires frequent surface cleaning, resterilization, and testing for planetary protection purposes, leading to substantial resource consumption and delay during the assembly process. Producing spacecraft components with antimicrobial surfaces could significantly reduce the hardware assembly time.

THERMAL MANAGEMENT OF EXTREME HEAT FLUXES; INNOVATIVE DUAL-CHANNEL FLOW BOILING WITH FEMTOSECOND LASER FUNCTIONALIZED METALLIC SURFACES

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Thermal management is often a limitation in advancing many space technologies. As components become smaller, compact solutions are required that can dissipate extreme heat fluxes with very high efficiency over a small area. The development of flow boiling in minichannels is one promising solution. However, there still exists a need for transformative improvement; addressing flow instabilities present in minichannel flow boiling such as pressureoscillations, large pressure drops, and a suboptimal critical heat flux is critical for the future of thermal management. Many studies have examined the effects of different surface morphologieson flow boiling heat transfer, however, the femtosecond laser surface processing (FLSP) of metallic surfaces offers a unique avenue for experiments. FLSP offers many advantages compared to other surface functionalization methods, such as structure permanency, scalability, single step process, and versatility that extends to a wide range of metals. This functionalizationmethod introduces self-organized micro- and nano-scale structures on the surface and has produced significant heat

transfer enhancement in minichannel flow boiling. The proposed work aims to overcome impediments observed in flow boiling with a novel dual-channel flow boilingsystem that utilizes FLSP of metallic surfaces. This design incorporates a cold, counterflow water channel added to the top of the main flow boiling channel, separated by a thin metal sheet.As water boils in the main channel, vapor produced will rise and contact the cold metal separatorwhere it will condense, thus reducing the accumulation of compressible vapor that causes manyof the observed instabilities. The boiling and condensing surfaces will be functionalized using FLSP, and the laser fluence and pulse count will be varied to observe the effects of different surface morphologies on instability suppression and heat transfer improvement. The results of this work will help create safer, more efficient, and more reliable thermal management systems.

CHARACTERIZATION OF SWIMMING PATTERNS OF *VORTICELLA* INCONFINEMENTS

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Vorticella is a unicellular animal that is usually found in freshwater habitats that has two forms: the sessile form and the swimming form. In the sessile (or trophont) form, *Vorticella* consists of a bell-shaped cell body with cilia around its mouth part, and a stalk anchoring the cell body to a solid surface. *Vorticella* creates water flow by beating these oral cilia for feeding. If the cell body is forced to be separated from the stalk, *Vorticella* uses the oral cilia to swim around in water, which is the false swimming form. In the true swimming (or telotroch) form for natural relocation, *Vorticella* retracts the oral cilia into the cell body and develops different cilia around the backside. The cell body then becomes more like a cylinder in shape. Since the cilia are located on only one end of the cell body, *Vorticella* is similar to a microscale submarine with the cilia being the propeller in both forms, and thus *Vorticella* is a unique model organism for micro-swimmers that can be more easily mimicked for developing microscale swimming robots. However, not a lot of observations have been done on the protozoan when it is in its swimming modes. In this study, we recorded the swimming pattern of *Vorticella* in the true and false swimming forms in two-dimensional (2D) confinements, which are formed by two parallel surfaces with a narrow gap, using video microscopy. Then, we obtained swimming trajectories by processing videos and analyzed swimming trajectories in terms of swimming speed and orientation, and mean squared displacement. In the false swimming form, *Vorticella* showed a variety of swimming patterns depending on different levels of confinement. They could swim upright if they had more room to swim around, or swim in circular patterns with limited space if they were more confined. In the true swimming form, *Vorticella* cells swam faster in more random ways than the false form. Since the 2D confinements of this study represent confinements of possible engineering applications of *Vorticella* and other micro-swimmers, the results from this study will contribute to engineering learnings on fluid dynamics as well as the development of microscale swimmingrobots for various applications.

COMMUNICATION AND TEMPERAMENT DURING TEAMWORK TASKS

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Communication is an integral component when individuals work together to complete teamwork tasks. The purpose of this study was to explore the influence of teamwork on one's verbal and nonverbal expression and one's self-perception of teamwork. Nonverbal communication domains included eye contact, gestures, and facial expressions when individuals' complete tasks that vary in the level of difficulty. Data from eighteen adults dividedinto six groups of three were used in this study. Participants were healthy adults and native English-speakers. Individuals were administered a self-esteem, temperament, and sociability questionnaire before completing the teamwork tasks. Varying task difficulty was measured by the total amount of time it took to complete a given assignment by the experimenters before thestudy began. During the experiment, tasks included both individual tasks and teamwork tasks. A language sample was gathered to indicate participants' verbal expression during the teamworktask and during a post- task interview. Results indicated no significant correlation on the impactof a more difficult last task (an individual task) on one's verbal expression during the teamworktask. With respect to verbal output during the task and post-task interview, results showed that verbal output of participants during the tasks was significantly correlated to verbal output duringa one-on-one interview post task. One may conclude that leaders of verbal expression carry theirexpressivity to other communication contexts. This study also evaluated individual self- perceptions of teamwork and how it impacted verbal expression during the teamwork tasks. Participants' self-perceived teamwork scores and verbal expression during the teamwork tasks was positively and significantly correlated. One who enjoys working in a team may express moreverbally and others who may not enjoy working as a team may restrict their verbal expressions.For the nonverbal domains, results indicated a non-significant relationship between self- perceived self-esteem and eye contact and self-perceived sociability and facial expressions. The results between self-perceived temperament and gestures suggested a trending relationship as individuals with higher positive temperament produced more gestures during interviews. The study also investigated eye contact when participants discussed tasks varying in difficulty. A moderate relationship was observed for the frequency of eye contact as individuals discussed more difficult tasks.

INTEGRATION OF ESA SENTINEL 2 IMAGERY TO AN EXISTING LANDSAT DATA ARCHIVE TO STUDY SPATIO-TEMPORAL PATTERNS OF ABOVEGROUND BIOMASS OF THE DOMINANT SALT MARSH SPECIES, *SPARTINA ALTERNIFLORA,* IN COASTAL GEORGIA

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The aboveground biomass of marsh cordgrass *Spartina alterniflora* has been measured via remote sensing techniques as part of the NSF Georgia Coastal Ecosystems Long Term Ecological Research project using a 37-year series of USGS Landsat 5 and 8 imagery. We've recently supplemented our Landsat archive with European Space Agency Sentinel 2 imagery forthe entire Georgia coast. Sentinel 2 provides significantly enhanced spatial resolution (nearly anorder of magnitude) and frequency of imagery for all *Spartina* salt marshes in Georgia (~100 km^2, representing 35% of all East Coast *Spartina* marshes). This higher spatial and temporal resolution with Sentinel 2 imagery provides significant improvements to our data sets, includingmore detailed mapping, increased statistical power (nine times more pixels), and frequency of coverage(every 5 days versus 8 days). We are able, with recent coast-wide high resolution wetlandmapping, to analyze three *Spartina* size classes (short, medium, and tall) for all ten USGS delineated Georgia tidal

watersheds. Climate and hydrological variables explain much of the variation in biomass for each of these three height classes of *Spartina*. Higher river discharges with reduced salinities, total precipitation, and mean sea level have positive relationships with, and best explain biomass variation for all dates. Higher frequencies and severities of droughts in the past two decades, leading to increased pore water salinities, were a major stressor. Importantly, average *Spartina* productivity was greatest in areas closest to larger river discharges (Altamaha, Savannah, Satilla, and Ogeechee Rivers) and was 300% greater in high precipitation, moist periods compared to drought periods. Since 1984, overall average biomassdeclines of almost 20% represent a reduction of ~81,000 MT in average annual above-ground, organic carbon biomass sequestration and organic matter export (both particulate and dissolved)and commercial fish and shellfish production in Georgia's coastal ecosystems.

USING REMOTE SENSING TO ANALYZE CHANGES IN PRODUCTIVITY AND BARE GROUND IN GRASSLANDS OF AUDUBON PRAIRIE AND THE SANDHILLS IN NEBRASKA

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While NASA and ESA-based satellite imagery can be useful for detecting change in vegetation at a larger spatial scale, UAVs (unmanned aerial vehicles or "drones") can detect change at a much smaller spatial scale. We used satellite- and aircraft-imagery as well as images taken from a DJI Phantom 4 Pro V2.0 drone to detect small-scale changes in vegetation in grass-stabilized sand dunes and prairies. Grass-stabilization is particularly key to stability of sand dunes and our original goal was to detect small-scale changes via drone imaging in the NebraskaSandhills; however, Covid-19 restricted travel. Instead, drone research was centered around a prairie north of Omaha, Audubon, and study of the Sandhills sites was done with Sentinel and National Agriculture Imagery Program (NAIP) satellite and aerial imagery. Audubon Prairie has three distinct field types that represent a continuum of recovery from disturbance, with a nativeprairie (never plowed), a restored prairie (used for crops until the mid-1990s when it was plantedwith native prairie plants), and a non-restored brome field (dominated by smooth brome—a plant that invades abandoned brome fields). In the spring of 2020, the three fields were burned. The prairie was flown with the drone during the fall growing season to compare vegetation andbare ground presence before and after the controlled burn. Analysis of 2019 imagery in comparison with 2020 imagery showed an increase in vegetation growth following the controlled burn on the prairie. Normalized Difference Vegetation Index (NDVI)—an index of greenness generated from reflectance in the red, visible, and near-infrared regions of theelectromagnetic spectrum—was used to calculate the relative quantity of vegetation present. NDVI values were higher in 2020 than2019 for the three fields of Audubon Prairie, indicating greater vegetation presence following the burn. In the Sandhills, 4-band aerial imaging, downloaded from the US Geological Survey (USGS)website, was used to study a location in Hooker County, Nebraska with active blowout sites. NAIP data, which is only available every two years in the summer, was paired with larger-scale Sentinel images. Preliminary results suggest that blowout size and bare ground presence responds to changing seasonal precipitationand spring temperature, as well as grazing management. Future research will pair drone imagingover the Sandhills with NAIP, Sentinel, and seasonal weather data to describe indicators of active blowout development and growth.

LIGHTWEIGHT, LIQUID METAL ELASTOMER COMPOSITE

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Soft, elastically deformable materials with high thermal conductivity are critical for numerous industries including healthcare, aerospace, automotive, and flexible electronics,where combinations of high mechanical compliance and high thermal conductivity are required. An emerging material architecture are elastomer composites that are composed of liq-uid-metal (LM)microdroplets embedded in hyperelastic polymers. These all soft-matter systems exhibit exceptional thermal properties, are electrical insulating even at high volume loadings, and remain soft and stretchable even at extremely low temperatures (-80 oC). Although these materials exhibit a unique combination of properties, the high density and high volume loading of the LM filler significantly increases the density of the composite, which is problematic for large-area thermal management and weight sensitive applications such as wearable electronics,aerospace thermal control, and clothing. Here, we introduce a new lightweight, LM inclusion that has a unique combination of properties including high thermal conductivity, low mass density, and high deformability when embedded into an elastomer matrix. Furthermore, the composition of the lightweight, LM inclusion can be tailored, enabling a large range in densitywith negligible changes to the thermal conductivity of the inclusion as the thermal conductivityis dominated by electrons. Experimental thermal conductivity results measured using the transient hot-wire method agree well with the Bruggeman and Cheng-Vachon models of effective medium theory. As with previously reported LM embedded elastomer composites, this composite shows increased thermal conductivity under strain and is able to achieve maximum strain above 400%. This work presents a new material architecture to enable independent control of the thermal conductivity and density of LM elastomer composites, offering new opportunities to tune functional properties of systems where weight is critical.

A HELE-SHAW CELL-BASED STUDY OF CONFINEMENT EFFECTS ON DROP COALESCENCE AND FOLLOWING BUBBLE ENTRAPMENT

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Drop coalescence is an interfacial fluid dynamics phenomenon that is widely observed in daily life as well as various scientific and industrial applications. When two drops come into contact to each other, a liquid bridge is formed between them due to molecular attraction. The curved meniscus of the bridge (or neck) results in a net force from surface tension, which pullsthe meniscus outwards. As a result, two drops merge into one larger drop. Since the surface energy is released during the merging process, drop coalescence occurs spontaneously without any external energy. Drop coalescence often occurs in limited spaces as shown by examples including drop-to-drop reaction or mixing in drop-based microfluidic devices, and coalescenceof molten metal powder particles in selective laser melting (SLM)-based additive manufacturing. Specifically, molten metal powder particles merge and form the melt pool whereprocess-induced pores develop during the SLM process. This porosity is a crucial problem of SLM-produced parts in terms of their mechanical property, reproducibility and quality. Understanding the dynamics of drop coalescence and pore formation in limited spaces appearscritical for further improvements of the

above applications. To elucidate the fundamentalinterfacial fluid dynamics of drop coalescence and bubble entrapment in a confinement, a Hele-Shaw cell was created for a model confinement by microfluidic fabrications. Two liquid drops were injected into the cell, and the growth dynamics of the liquid bridge was measured by high-speed microscopy and image processing. The effects of the confinement on drop coalescence and following bubble entrapment were investigated by changing the surface wettability and gap height of the Hele-Shaw cell, and the surface tension and surface wettability of working fluid andthe Hele-Shaw cell, respectively. It was found that the neck grew in time with the scale exponentof 2/3, and that entrapped bubbles were located above and below the neck (i.e., near the inner surface of the Hele-Shaw cell). In conclusion, the dynamics of drop coalescence in the confinement was partly revealed by the scaling law and bubble entrapment found in this study.

DEVELOPING SMALL MOLECULE INHIBITORS THAT INHIBIT RAD52-BASED DNA REPAIR FOR CANCER THERAPY

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An accumulation of mutations in DNA enhances the risk for a person to develop cancer. The mechanisms of maintaining the stability of the genome are multifaceted with several tools to repair DNA. The most extreme form of damage is a double-strand break (DSBs). DSBs arisefrom both internal and external cellular processes, including radiation exposure. Several cancers,such as pancreas, ovarian, or breast cancer, have a deficiency in DNA repair mechanisms. Thesecancer types often have dysfunctional homologous recombination (HR). HR is a DNA repair mechanism used to mend DSBs in DNA —inability to repair DSBs largely contributes to genomic instability and fuels carcinogenesis. The dominant mediators of HR include BRCA1, BRCA2, PALB2, and RAD51. When the major pathway is disrupted cancer cells become dependent on the RAD52-based HR pathway for survival. This is clinically relevant in cases ofhigh-grade serous ovarian carcinoma (HGSC), which accounts for up to 70% of diagnosed ovarian cancer cases. Approximately half of HGSC patients have nonfunctional BRCA-based HR repair. These tumors are addicted to the RAD52-based pathway, and once RAD52 is inhibited the cells cannot repair the DSBs— eventually leading to tumor cell death. We aimed to target this weakness. We began developing novel small molecule inhibitors (SMIs) to targetthe RAD52:RPA protein-protein interaction that forms at the beginning of repair and induces synthetic lethality. After previously identifying 12 potential inhibitors of this interaction in a fluorescent assay (FluorIA), we worked to delineate the biophysical characteristics of these SMIsusing Surface Plasmon Resonance (SPR)to aid in the triage and creation of more selective inhibitors. We continue to investigate potential structural modifications that improve selectivityand inhibitory activity to ultimately generate new, safe and efficacious cancer therapy options. This project is relevant to NASA's Human Research Program (HRP) mission which declares radiation and carcinogenesis research that minimizes potential risk to crewed-missions as a critical interest. This research aids in understanding the consequence of radiation-induced DSBsin DNA, and addresses potential anti-cancer therapeutic applications.

CHANGES IN SENSORIMOTOR ACTIVATION DURING THE USE OF A NOVEL TOOL

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The use of a novel tool such as a prosthesis must provide a sense of control or agency for the user to associate the tool's movement as a movement that they initiate. Additionally, as the tool becomes incorporated into the user's sense of self, the brain undergoes neuronal changes to incorporate the tool. A gap exists in the literature that describes how these processes affect the rejection or acceptance of upper limb prostheses. Prosthetic simulators are tools used within rehabilitative settings that aid amputees with becoming more familiar with their prosthetic device with the unaffected limb or have been used to investigate learning paradigms. However, it is unknown if these simulators truly emulate the neural responses of using an actual prosthesis.This project aimed to expand our current knowledge in the brain's response to novel tool use in the presence or absence of external perturbations, such as upper limb reductions. We utilized functional near-infrared spectroscopy (fNIRS) to investigate the effects of prosthetic simulator use in children with typically developing limbs compared to children with upper limb reductions(ULR) using their prosthesis during a unimanual dexterity task. Additionally, we sought to describe differences in activation during simulator use and the non-preferred hand in the TD group. Our regions of interest were the supplementary motor area (SMA), the primary motor cortex (M1),and the primary somatosensory cortex (S1). We found that the ULR group had decreased activation levels within the motor areas (SMA, M1) of their cortex compared to the TD group. No differences were observed between groups within S1. Compared to the TD group'snon-preferred limb, the use of the simulator attenuated activation within the SMA. Use of the simulator resulted in insignificantly lowered activation within M1. However, activation in S1 was significantly increased during simulator use than in the non-preferred limb. Reductions in motor activation within the ULR group may be evidence of weakened motor representations ofthe affected limb. The non-significant differences in S1 activation between groups and the increased activation evoked by the use of the simulator may suggest rapid changes in feedbackprioritization during tool use. We suggest that prosthetic simulators may be sufficient to elicit increased reliance on spatio-visual feedback during motor tasks in individuals with limb reductions and typically developing children. This simulation may help develop future prosthesis rehabilitative training or the improvement of tool-based skills.

THE USE OF 3D PRINTED MODELS TO IMPROVE THE UNDERSTANDING OF COMPLEX ORTHOPEDIC TRAUMA

David Salazar and Jorge Zuniga, Ph.D., Department of Biomechanics, University of Nebraska at Omaha, Omaha, NE 68182; Justin Siebler MD, Department of Orthopedic Surgery and Rehabilitation, University of Nebraska Medical Center, Omaha, NE 68105

3D printing is a popular method of additive manufacturing that has a large potential impact within the field of medicine. One application that has been highlighted in the past is the ability to replicate complex anatomy for educational purposes. Orthopedic operations areamongst the most complex due to the unique anatomy of structures such as the pelvic bone and would likely benefit from the incorporation of 3D printed models. The purpose of this study was to create 3D models of complex orthopedic trauma to improve education of how to perform the reconstruction for

medical and residency students. 7 unique cases of knee, acetabular, and pelvic operations were 3D printed using low-cost methods. Due to restrictions caused by Covid-19, only 5 of the 20 students included in the study were allowed to utilize the3D printed models in person to supplement their orthopedic trauma comprehension. The differences between those who saw the models and those who did not were compared using a standardized survey to investigate advantages in learning caused by implementing unique fracture models. The results of this study found no significant difference between the groups based on the current sample size($p = 0.61$). However, further correlation analysis indicates that a larger sample size may find group differences as we saw significant correlation values between year in residency and average survey score for both the group that saw the models ($R = 0.91$, $p = 0.031$) and the group that did not ($R = 0.53$, $p = 0.04$). These findings demonstratethat the inclusion of 3D printed anatomic models likely improves comprehension of complex orthopedic fracture anatomy and can easily be implemented at most institutions thanks to its low manufacturing cost.

NASA JET PROPULSION LAB UNIVERSAL TOOL RACK AND CHANGER (UTRAC)

Sam Harre, Jack Barrett, Jonathan Hannaford, Tyler Heiman and Nick Swerczek
Department of Mechanical Engineering, University of Nebraska-Lincoln, Lincoln, NE 68588

The NASA JET PROPULSION LAB UNIVERSAL TOOL RACK ANDCHANGER SYSTEM, or UTRAC, is a development to address the challenge of using a single robotic arm to use multiple tools. The UTRAC system is an implement to be installed on future lander missions to Luna and other extraterrestrial environments. This concept stems from the problem that for multiple tools to be used on a lander or rover, there needs to be multiple arms. By implementing a lockable interface (changer side) and lockable storage system (rack side), it is possible for one arm to perform multiple different tasks with various tools. The project is currently in its initial design and testing phase, and consists of a tool interface, which connects to a tool rack and a tool changer. The interface between an arm and changer will also contain electrical pins. These pins consist of 10 data pins and 2 power pins which will transfer through totools. The proposed locking mechanism is a ball locking mechanism with a single actuator. Thissystem is entirely mechanical, using the rise and fall of cams to actuate the system powered by asingle actuator. A prototype of this concept is being built out of 3D printed parts and off the shelfhardware. Testing will be automated using an Arduino script, with electrical connection to verifya complete cycle. A cycle will be defined as stowing a tool, retracting, and recollecting the tool from the rack. The Arduinoscript will run 200 of these cycles, and the goal for the end of this process is to have a solution that will have a successful connection 95% of the time with 95% confidence. This project is under supervision of the NASA Jet Propulsion Lab, and is partially funded by NASA NE Space Grant.

TESTING PEROVSKITE SOLAR PANELS WITH CUBESAT

John Helzer, Joel Murch-Shafer, Michael Hackett and MJ Schuster, Department of Engineering, University of Nebraska-Lincoln, Lincoln, NE 68588

In the past decade, CubeSats have provided incredible opportunities for research and technology development. Programs like NASA's CubeSat Launch Initiative aim to allow inexperienced teams to test technology in a very cost-effective way. Nebraska is currently oneof

nine states that have yet to launch a cubesat - but that will hopefully change soon! The University of Nebraska-Lincoln's Aerospace eXperimental Payloads (AXP) team is partnering with middle and high school students across Nebraska to form the Nebraska Big Red Satellite team (NBRS) and develop a cubesat for the CSLI, Big Red Sat-1. We will also join teams from North Carolina and Florida to share experience and establish a telemetry system. NBRS aspires to directly engage students with STEM and gain engineering experience. The 13 middle/high school students on the team have researched, designed, and presented about Big Red Sat-1 and its payload. While waiting to hear which proposals are accepted by NASA, we are working on a high-altitude balloon project with students in teams to design payloads. A crucial part of their experience is initiative; the undergraduate AXP team does any advanced technical work and oversees the whole project, but the 8th-11th grade students have ownership over their payloads. NBRS also has a student leadership team including president and leads for each of the subsystems of the CubeSat. This allows the students to gain not only technical knowledge, but the interpersonal skills and leadership abilities to succeed in their futures. NBRS's CubeSat, Big Red Sat-1, will test the efficiency and lifetime of perovskite solar panels in space. Perovskites are an emerging photovoltaic technology with a different chemical structure than traditional silicon solar panels. Their low mass, high efficiency, and increased flexibility make them an attractive solution for solar arrays both on Earth and in space. We will verify their effectiveness in low-earth orbit by testing an array of perovskite solar panels on our cubesat against the traditional silicon cells used in space . Our mission will include an array of half silicon cells and half perovskite cells,with both types of panel on each face to directly compare their specific power. We will also determine whether perovskite solar panels can collect light on the dark side of the earth. By testing the greater power efficiency, lifetime, and superior light collection ability of perovskitesolar panels, we will demonstrate that perovskite photovoltaics are a promising solution for future space missions.

REPLACING A COMMUNCATION MODULE ON A MOVING MAST USING AN AUTONOMOUS DRONE

Ryan Karl, Grace Becker, Zury Vasquez, and Gerson Uriarte, Department of Engineering, University of Nebraska-Lincoln, Lincoln, NE 68123

The International Aerial Robotics Competition, IARC, is a competition based on pushingthe edge on Aerial Robotics. Each time their competition is completed, they create a new missionset to be increasingly difficult from the last. In 2021, the current mission is mission 9. Mission 9 has an aerial vehicle fly around a 2 km obstacle course, with several moving objects to avoid.Once the vehicle is finished with the course, it is to move over to a mast. This mast will have a communication module on it that is detachable. The mast is also swaying in a periodic motion. The vehicle will remove the old module and replace it with one that it has been carrying. The vehicle will then fly back through the course and land on the starting platform. For the durationof the entire course, the vehicle must be fully autonomous. The University of Nebraska-Lincoln's UAV team will compete in this competition using a quad-copter drone with 2 motors on each arm, named Lord FarQuad. Lord FarQuad employs several advanced systems meant for the completion of the competition. It uses several LIDAR sensors, advanced cameras, and machine learning algorithms to see the world around it for object detection and avoidance. Once Lord FarQuad is at the mast it will track the movement of the mast for the removal and replacement operations. To remove, Lord FarQuad will use two hooks to grab onto the module and remove it.To replace, Lord FarQuad will use an arm system and the tracking of the mast to accurately insertthe new module

onto the mast.

REDESIGN AND CONSTRUCTION OF A HIGH-POWER ROCKET

Are Engstrand, Judith Brown, Phoebe Pena and Grant Meyer, Department of Mechanical and Materials Engineering, University of Nebraska-Lincoln, Lincoln, NE 68588

As a division of the UNL Aerospace club, Husker Rocketry designs, constructs and flies high-power rockets for a competition of its choosing annually. This year, the UNL Husker Rocketry team has focused on the completion of a competition rocket from last year, designed for the Spaceport America Cup. The rocket, named Andromeda, is approximately 9 ft. long and has a 6 in. diameter. It will be powered by a commercially produced motor to reach an altitude of 10,000 ft. While the initial rocket design was completed in early 2020, there have been several adjustments over the past academic year to ensure that the rocket is both safe to fly and feasible to construct. The initial design contained a large hole in the side of the payload bay from which the payload would have been ejected. Additionally, the couplerlengths between this section and the rest of the rocket were too short. After discussion with a more experienced rocketeer, Husker Rocketry decided to redesign the payload bay and removethe side ejection system and hole to make the rocket safer and constructible. The newer modelwill have a camera within it that will be able to record the flight of the rocket and will be traveling around Mach 1, 767 mph. This rocket will be based on designs and simulations froma rocket design simulator called OpenRocket, which will ensure that the rocket is stable and safe for launch. The rocket will also be fabricated by using fiberglass for the body tubes and nose cone, and carbon fiber for the fins. These parts for the rocket were commercialized off the shelf from various rocketry retailers.

UNIVERSITY OF NEBRASKA-LINCOLN AEROSPACE ROBOTIC MINING COMPETITION TEAM

Aaron Norlinger, Johnathan Cerny, Tyler Heiman, Ezra Bailey-Kelly, Christian White, Jack Barrett and Justin Morrow, Department of Engineering, University of Nebraska-Lincoln, Lincoln, NE 68588

The University of Nebraska-Lincoln Aerospace Robotic Mining Competition team is a group of undergraduate students at UNL that competes in NASA's annual Robotic Mining Competition (RMC). Each year the team designs, builds, and tests a robotic rover capable of mining for icy reoglith underneath a simulated lunar surface. The competition has been designedto closely resemble the conditions at the lunar south pole, where the Artemis program plans to send rovers ahead of manned missions to the moon. NASA hosts this competition annually at Kennedy Space Center with 50 teams from different universities across the country. Due to ongoing COVID-19 concerns, the competition was changed to be virtual, and will conclude with the submission of a systems engineering paper detailing the project and results to the NASA judges. This year, the team has grown substantially and now includes approximately 30 undergraduate members. The robot design was divided into five subsystems: drivetrain, excavation, material handling, electronics, and programming. This year, the drivetrain subteam has been testing different materials for the wheels of the robot, including 3D printed platics andflexible resins. The design for the excavation subsystem includes a large trencher on an actuatedplatform, allowing the robot to mine for regolith much farther below the surface. The material handling subsystem stores

the excavated regolith in a hopper until it is ready to be deposited. The hopper is then raised via a scissor lift and tilited to deposit the collected regolith. The electronics subsystem was designed to be dust resistant and modular so that individual parts canbe more easily disconnected and replaced without disassembling the entire system. The programming subteam focused on the control of the robot and how the person operating the rover will control each part of it. Currently, the project is in the manufacturing process and eachsubsystem is being tested individually as it is completed. Early testing has been promising and has already lead to some improvements being made in its functionality. The drivetrain and material handling subsystems have been tested the most extensively, allowing these subteams tomore clearly identify any issues with the design and start working to correct them.

UNIVERSITY OF NEBRASKA-LINCOLN DESIGN/BUILD/FLY TEAM

Kevin Zhao, Thomas Curry, Thomas Schoenstein, Ryan Karl, Samuel Schneider and Herve Mwunguzi, Department of Engineering, University of Nebraska-Lincoln, Lincoln, NE 68588

The University of Nebraska-Lincoln (UNL) Design/Build/Fly (DBF) Team is an undergraduate design group that competes in the American Institute of Aeronautics and Astronautics (AIAA) DBF Competition. The event tasks teams from around the world to design, build, and iteratively test remote controlled aircrafts that have been optimized for specific design challenges. These challenges are announced annually by AIAA and can range from an aircraft capable of storing and releasing several payloads remotely with specific timing to developing a compact folded aircraft that must take off after being ejected. The competition structure consistsof three flight missions that test the flight capabilities of the aircraft unloaded, loaded, and performing competition-specific tasks. There is also a single ground mission used to display theeasy and speed of an aircraft's preflight preparations. The competition is made to mirror real world aircraft design challenges and flight situations, with the constant change in design specifications generating innovative solutions. Due to the ongoing COVID-19 situation, the competition for this year has been shifted to an virtual event where teams will submit a video presentation of the performance of their aircrafts. The AIAA DBF Competition for 2020-2021 has given teams the goal of developing an aircraft capable of securely storing several mock sensors with impact resistant cargo containers. For one mission, a mock sensor must be deployedand retrieved from within the aircraft while in flight and display a blinking light pattern that canbe discernable from ground level. The UNL DBF Team is divided into administrative and design sections, with the design section including the structural, aerodynamics, electrical, and manufacturing subteams. The structural and aerodynamics subteams have been working closely with the manufacturing subteam going into the second aircraft prototype to develop and constructa lighter, more aerodynamic aircraft body with a smoother form. The electrical team has developed compact modular sensor electronics to be easily fitted for any sensor design variation, as well as the electronics for the sensor deployment/retrieval subsystem. Early calculations and testing for the deployment/retrieval mechanism show promising results under loading conditions.With the next scheduled test flight, the team will be able to more thoroughly assess the stability of the deployed-sensor flight configuration and troubleshoot and correct any subsystem issues.

DYNAMIC SERVICE PROVISIONING OF NON-UNIFORM TRAFFIC IN SDN ENABLED OTN OVER WDM NETWORKS

Shideh Yavary Mehr and Byrav Ramamurthy, Department of Computer Science and Engineering, University of Nebraska-Lincoln, Lincoln, NE 68588

Improving dynamic service provisioning significantly increases the network efficiency. In highly dynamic traffic scenarios, the efficient use of Software Defined Networking (SDN) features in Optical Transport Networks (OTN) over wavelength DivisionMultiplexing (WDM) networks plays an important role in improving service provisioning. Also, a crucial issue in WDM network is the call drops due to fluctuation in traffic. Therefore, evaluating any method under non-uniformity of traffic is necessary. Earlier, we proposed a strategy called Resource Delayed Released (RDR) to reduce Service Provisioning Time (SPT), and Blocking Probability (BP). Those goals were achieved by delaying the release of an optical channel when the channel does not carry any services. This method was originallystudied under uniform traffic while, real-world traffic distribution is extremely non-uniform. In particular, we studied how uniform traffic load influences the SPT and BP. We posit that their model, even under non- uniform traffic, will give us the same impact on SPT and BP with some fluctuation. In this work, the effects of RDR on SPT and BP under the non- uniformity of traffic will be investigated. Also, the amount of this traffic fluctuation will be obtained. We will show that the RDR strategy would generalize well to non-uniform traffic distributions even under heavy traffic. Bandwidth Blocking probability (BBP) is another metric that will be evaluated in this work to show the network performance. The distribution of human population affects things such as available technologies, which in turn affects network traffic being generated at a particular location. Population centers also tend to affect infrastructure. Therefore, in this work, the particular traffic formulation, which is directly related to population density, was chosen. For non-uniform traffic simulation, we used a mesh topology with the 14 most populous cities in USA as of 2019 as 14 nodes in our topology with19 links. Simulation results were generated based on a wide variety of traffic scenarios under non-uniform traffic distributions. We show that SPT decreases 41-75%, BP reduces 29-58% and BBP reduces 35-75% under non-uniform traffic.

ANTHROPOLOGY Chairperson: Taylor Livingston, University of Nebraska-Lincoln

FRIDAY, APRIL 23

MORNING SESSION - 2

10:20 ZOOM Session opens for participants to join: https://unl.zoom.us/j/94706076560

10:35 WELCOME

10:40 KOREAN WAR: INITIAL ENTRY INTO THE WAR, Laurene Lee (abstract)

11:00 US POLICY TOWARDS THE XINJIANG RE-EDUCATION CAMPS, Brianna Myers (abstract)

11:20 PREHISTORIC CERAMICS OF THE FREMONT: TEMPER ANALYSIS, Kora Seats (abstract)

12:00 **LUNCH**

1:00 **BUSINESS MEETING** https://unl.zoom.us/j/97870996278
Nebraska Academy of Sciences (all members)
State of the Academy
Awards Ceremony
Vote by NAS members on Revisions to NAS Constitution
Comments from Members-at-Large

1:30-2:30 **MAIBEN LECTURE** https://unl.zoom.us/j/9289316099
Dennis Ferraro, *Reflections of a Nebraska Herpetologist*

AFTERNOON SESSION - 3

2:50 p.m. ZOOM Session is open for participants to join https://unl.zoom.us/j/94706076560

3:00 DISABILITY AND CLIMATE CHANGE: LACK OF ACCESSIBLE ADAPTATION AND MITIGATION EFFORTS, Morgan McGee (abstract)

3:20 COSMOPOLITAN SOUTH KOREAN BEAUTY CULTURE: PALENESS, WHITENESS, AND PLASTIC SURGERY IN CONTEMPORARY SOCIETY, Serina Nakagawa (abstract)

3:40 AUDIENCE PERCEPTIONS OF PLACE AND PLACELESSNESS PRESENTED IN STAGE PRODUCTIONS, Madeline Reiher (abstract)

ANTHROPOLOGY ABSTRACTS

KOREAN WAR: US INITIAL ENTRY INTO THE WAR

Laurene Lee, Anthropology, School of Global Integrative Studies, Universityof Nebraska-Lincoln, Lincoln, NE 68588

In the middle of the 20th century, the United States had increasing concerns about Russian expansion in Northeast Asia following the power vacuum created with the defeat of Japan in 1945, and a weak and divided China unable to emerge as a great power to render a new balance in the region. South Korea was occupied by the United States while North Korea was occupied by the Union of Soviet Socialist Republics (USSR), and the 38th parallel becamethe demarcation line between the Soviet and American occupation forces in the peninsula. In 1948, the authoritarian socialist Union of Soviet Socialist Republics and the liberal democraticUnited States established independent governments in their respective occupational zones, the Democratic People's Republic of Korea and the Republic of Korea, respectively (Stueck, 2013). Begun with North Korea's attack on June 25, 1950, the Korean War lasted until July 27, 1953 when the signing of armistice took place. The war can be roughly divided into three sections consisting of: the initial entry into the war, the march into the north of the 38th parallel, and the final two years of stalemate. This presentation will analyze the initial phase ofthe Korean War inregards to the following factors: broader U.S. interests in relation to the war, why the U.S. used force and why it used force in a particular manner, the domestic actorsthat influenced U.S. decision-making, and alternative accounts of the reasons for war.

DISABILITY AND CLIMATE CHANGE: LACK OF ACCESSIBLE ADAPTATION AND MITIGATION EFFORTS

Morgan McGee, Global Studies, School of Global Integrative Studies, University of Nebraska-Lincoln, Lincoln, NE

Climate change, caused by increasing fossil fuel extraction, consumption, and emissions significantly impacts the Earth's delicate balance. These changes threaten the overall survival of the planet including its human and animal populations. To best prepare for an era of anthropogenic climate change, experts propose various approaches and solutions including mitigation, adaptation, and resilience, yet nearly all leave out disability as an essential consideration. Few, if any, consider accessible adaptation and mitigation efforts. I argue that to be successful, discussions and policymaking around climate change must be holistic and place the concerns and needs of the disabled populations at its core. In this presentation, I will evaluate the disproportionate impact of climate change on the disabled population through a feminist disability studies lens. I begin with a review of the disjuncture between environmental studies and disability studies when it comes to climate change and an explanation of the ontological and epistemological contours of disability. Next, I consider the impact of omitting disability experience from climate change adaptation and mitigation effortsand the harm caused by the current climate discourse on people with disabilities. Finally, I examine the climate change policies of the United States and Australia, two countries considered to have made significant advances in disability rights movements and legislation by highlighting failures within policymaking that directly harm vulnerable populations as it relates to climate change. Finally, I contend that discussion of disability remains central toclimate-change policymaking discussions and is a prerequisite to making a warming world more accessible for everyone.

US POLICY TOWARDS THE XINJIANG RE-EDUCATION CAMPS

Brianna Myers, Global Studies, School of Global Integrative Studies, University of Nebraska-Lincoln, Lincoln, NE 68588

United States-China relations have been tense for hundreds of years, with the recent past being no exception. Part of the recent tension has been caused by the usage of the XinjiangRe-Education Camps. These camps have been operational since 2017 and are managed by the Xinjiang Uygur Autonomous Region government and its Chinese Communist Party provincial committee. Throughout the time these camps have been open, at least one million people, members of minority groups in China, have been forced into them. While the Chinese government totes the camps as "Vocational Education and Training Centers," it does not take astretch of the imagination to deem them similar to those used by Nazi's during the Holocaust. The purpose of this presentation is to explore the efficacy of proposed ways to address and hopefully solve the persecution of Uygur Muslims and other ethnic minorities, such as Kazakhs,Kyrgyz and other ethnic Turkic Muslims, Christians, and some foreign citizens such asKazakhstanis, in the Xinjiang Re-Education Camps in China. This analysis includes solutions at personal, national, and international levels. My findings conclude the starting point should be with trade reduction and escalate to taking China to the International Criminal Court if the situation is not fixed. Throughout the entire process, consumers can practice consumer boycotting by not purchasing goods from the companies that use labor from these camps.

COSMOPOLITAN SOUTH KOREAN BEAUTY CULTURE: PALENESS, WHITENESS, AND PLASTIC SURGERY IN CONTEMPORARY SOCIETY

Serina Nakagawa, Global Studies, School of Global Integrative Studies, University of Nebraska-Lincoln, Lincoln, NE 68588

South Korea is known as the "plastic surgery nation" with a rate of plastic surgery per capita surpassing both the United States and Brazil in 2015. Plastic surgery rates for women aged18-20 are estimated at 33%, with an overall rate of 18% for women of all ages in 2018. However, most plastic surgery clinics are concentrated in the Gangnam neighborhood of Seoul. Gangnam boasts the most English schools, the highest density of skyscrapers, and some of the highest valued housing in South Korea. These markers of a capitalist society indicate a highly Westernized presence in Gangnam. Scholars have argued that the prevalenceof blepharoplasty (eyelid surgery) to create a crease in the eyelid, which reflects a common European phenotype, glutathione (skin lightening) injections, and rhinoplasty (nose job) to have a more pronounced nose height and reduce the nose width suggests a desire to mimic a distinctly White beauty standard. Other scholars and some patients suggest these operations enhance Korean features to reflect a traditional beauty standard. Utilizing cultural anthropology and gender studies, I will present a literature review on how Western beauty ideals have influenced South Korean body politics in recent history and how these ideals are expressed and interpreted through plastic surgery. My findings indicate that contemporary plastic surgery in South Korea is rooted in the quasi-colonial experience of its history under the authority of the United States during and after World War II (1945-1955). The U.S.'s continuous involvement on the peninsula has led to an increasingly high value on White features and the consumption of cosmopolitan material cultural goods. Cosmopolitanism is adisguised form of Whiteness in which material cultural goods such as name brand luxury goods and high-end beauty products are Western or intertwined with Western aesthetics. Similarly, common surgical procedures reduce "excessively ethnic" features

and confer a middle-class cosmopolitan status. Koreans embody these forms of White cosmopolitanism inGangnam plastic surgery clinics. However, surgical practice is changing. Procedures such as calf-muscle shaving and forehead implants are common, yet they are virtually unheard of outside South Korea. Today, these procedures indicate a shift in beautystandards where South Koreans are negotiating and re-interpreting traditional Korean idealsand Western ideals into a new, distinctly Korean, ideal.

AUDIENCE PERCEPTIONS OF PLACE AND PLACELESSNESS PRESENTED IN STAGE PRODUCTIONS

Madeline Reiher, Geography, School of Global Integrative Studies, University of Nebraska-Lincoln, Lincoln, NE 68588

In *RENT*, the character Tom Collins dreams of a life free of the worry and grime and homophobia he faces every day in New York City. His "I want" song, the song that sets up the problem in the musical, is "Santa Fe." In this song, he puts these desires of escape into words as he pines for the freedom and peace that he believes can only be found in Santa Fe. This sense of placelessness and longing for a different and seemingly ideal location is written to resonate strongly with the show's original target audience of starving artists livingin poverty in New York City. The broader ideas of discontent with the status quo and desire for escape allow the show to resonate past this target audience and is in part what makes *RENT* so popular in the mainstream, and what keeps its popular today. The goal of this presentation is to further the study of film as a representation of geographic thought by incorporating the methods of formal film review into a geographical reading of *RENT*. The concepts of senses of: place and placeless-ness, distance and distance decay, and mental maps and spatial cognition are all discussed as primary themes that emerge when the film ofthe theatrical production is read through a geographical lens.

PREHISTORIC CERAMICS OF THE FREMONT TEMPER ANALYSIS

Kora Seats, Anthropology, School of Global Integrative Studies, University of Nebraska-Lincoln, Lincoln, NE 68588

My presentation will focus on my analysis of prehistoric Fremont pottery sherds (pieces of pottery) to determine the type of temper uses and techniques used in constructing these vessels. For my analysis, I evaluated 177 sherds from the Hoyt Field School Site in Boulder, Utah. The property was owned by the Hoyt's and located outside Capitol Reef National Park. The site's occupants were Fremont peoples of the San Rafael variant. Within this presentation,I will be discussing the culture of the Fremont as a hunter gatherer group and the overall background of the site, as it pertains to the Fremont. I will also be alluding to the importance ofthe evidence that points to how over time, the Fremont started to develop pottery, tools, figures,and other such material culture that is more evident of a settled way of life. The presentation will focus on the methods used in my research, which include a preliminary analysis from all the artifacts from the Hoyt site. This allows me a better understanding of the number of sherds total in the collection, and the ability to then categorize each sherd. Each sherd was analyzed fortemper type (material mixed with clay), modifications (changes to the clay), coil construction (use of clay coils to make the pot), the presence of a rim, and form of the sherd. The results andtheir implications involve the classification of all the sherds using Madsen's Prehistoric Ceramics of the Fremont, the use of distinct pottery styles consistent with the San Rafael VariantRegion, and suggesting geographic allocations for temper source.

APPLIED SCIENCE & TECHNOLOGY Chairperson: Mary Ettel, Wayne State College

FRIDAY, APRIL 23

MORNING SESSION - 2

10:00 ZOOM Session opens for participants to join https://wsc.zoom.us/j/96626024225

10:15 WELCOME

10:20 FAST FPGA BASED COMPUTATION OF SHORTEST PATH ALGORITHMS AND ITS IMPLEMENTATION USING DE2 FPGA BOARD
Satish Reddy Modugu and Hassan Farhat (abstract)

10:40 ALTERNATIVE RELATIVE LOCALIZATION IN MULTI-AGENT SYSTEMS Rui Yang, Hassan Farhat and Azad Azadmanesh (abstract)

12:00 **LUNCH**

1:00 **BUSINESS MEETING** https://unl.zoom.us/j/97870996278
Nebraska Academy of Sciences (all members)
State of the Academy
Awards Ceremony
Vote by NAS members on Revisions to NAS Constitution
Comments from Members-at-Large

1:30-2:30 **MAIBEN LECTURE** https://unl.zoom.us/j/9289316099
Dennis Ferraro, *Reflections of a Nebraska Herpetologist*

FAST FPGA BASED COMPUTATION OF SHORTEST PATH ALGORITHMS ANDITS IMPLEMENTATION USING DE2 FPGA BOARD

Satish Reddy Modugu, Hassan Farhat, College of Information Science and Technology, University of Nebraska at Omaha, Omaha, NE 68182

Many applications in today's life require high-speed shortest path computations. These computations are widely used in applications such as telecommunications, robotics, maps navigations etc. In general, for such computations algorithms like Dijkstra and Travelling Salesman Problem (TSP) are used. In our project we aim to decrease the execution time of such shortest path finding algorithms using Field Programming Gate Arrays (FPGA). Our final goalisto design an FPGA based accelerator to compute the shortest path and apply it to practical Industrial problems. Most of the applications use shortest path computation algorithms that areimplemented using high level programming languages such as C, C++, JAVA and Python. Using low level programing such as VHDL and implementing FPGA-based accelerator to calculate the shortest path can help us achieve high performance at low cost. In our project implementation, we have considered a sample graph that models travelingsalesmen problem and used Dijkstra algorithm to find the optimal path. We did the algorithmimplementation in both high-level programming languages like C and low-level language likeVHDL and verified the VHDL implementation on the DE2 FPGA board. The algorithm weimplemented using VHDL utilizes the concepts of parallelism to reduce the runtime complexity.We used Intel DE2 FPGA Board to run our VHDL Dijkstra algorithms implementation. We did multiple simulations of the VHDL implementation of shortest path algorithms using themodel SIM simulation tool before running the code on DE2 board. DE2 board connected with monitor and mouse acts a complete working system, input is given through mouse by selectingthe nodes on the monitor, the shortest path between the selected nodes is displayed as the outputon the monitor by drawing the line between the output nodes. We have evaluated our algorithmon a graph with 16 nodes, the execution time of our FPGA algorithm is around 11 microseconds,when such graph with 16 nodes is implemented on high level language like C running on the microprocessor takes around 400 microseconds.

ALTERNATIVE RELATIVE LOCALIZATION IN MULTI-AGENT SYSTEMS

Rui Yang, Hassan Farhat, Azad Azadmanesh, Department of Computer Science, University of Nebraska at Omaha, Omaha, NE 68182

In a distributed multi-agent system (MAS), agents are aware of their local surrounding according to their sensing and communication range. In such systems, agents could be robots, microcontrollers, drones, software units, etc. Hence, a Multi-Robot System (MRS) is a MAS. In such systems, it is often crucial to dynamically determine the direction of agents or events relative to other agents (e.g., whether an agent is to the left of another agent). The earlier work utilized geometric measures such as arctan function to assist agents indistributing themselves in a circular formation uniformly and autonomously. To achieve this goal, once on the circle, each agent had to move counterclockwise (left) to adjust its distance with its neighbors. The counterclockwise movement necessitated the use of arctan in thedesign of algorithms to determine whether the neighbors of an agent fell within its 180° space in counterclockwise motion. This resulted in complex procedures during the development phasethat has led to introducing errors in the ad-hoc maintenance of the simulation software. This study has exploited an alternative approach to

relative localization by taking advantage of an implicit function. The approach has resulted into the following contributions: The implicit function is simply taking advantage of the coordinates only; 2) The approach has reduced the complexity of the relative localization determination; and 3) The algorithm foruniform distribution of agents (once they are on the circle) has become simpler to develop and maintain. This study is in the process of developing the new simulation code in Python.

BIOLOGICAL & MEDICAL SCIENCES Chairperson: Annemarie Shibata, Creighton University

FRIDAY, APRIL 23

MORNING SESSION – A1

7:45 ZOOM Session opens for participants to join https://unk.zoom.us/j/93308210184

8:00 WELCOME

8:05 COMPARATIVE ANALYSIS OF THE GENETIC REQUIREMENTS FOR FILAMENTATION IN DIVERGENT *C. ALBICANS* STRAINS. Akram Almansob, Elias Smith, Jill Blankenship, and Lizbeth Basilio (abstract)

8:25 BACTERIOPHAGE THROUGH THE DIGESTIVE TRACT OF MAMMALS. Kia Liermann and Kay Crabtree (abstract)

8:45 USING BRED-CONSTRUCTED GENE KNOCKOUTS TO DETERMINE FUNCTIONS OF BACTERIOPHAGE GENES IN THE *MYCOBACTERIOPHAGE* FUDGETART Ali Osborn and Erin Doyle (abstract)

9:05 USING BACTERIOPHAGE RECOMBINEERING OF ELECTROPORATED DNA (BRED) TECHNIQUE TO MARK ESSENTIAL AND NONESSENTIAL GENES FOUND IN A BACTERIOPHAGE'S GENOME. Maddy Sladky (abstract)

9:25 RE-EXAMINATION OF FILAMENTATION REQUIREMENTS OF *C. ALBICANS*: EARLY FILAMENTATION PROFILES NEAR POST-DIAUXIC PHASE. Elias Smith, Amanda Sisney, Timothy Saqueton, and Jill Blankenship (abstract)

9:45 TESTING THE VIABILITY OF A YEAST INSULATOR ASSAY FOR SCREENING MAMMALIAN PROTEINS. Trevin Alberts and Brett Schofield (abstract)

10:00 **BREAK**

MORNING SESSION – A2

10:20 BIOMEDICAL APPLICATION AND BIOCHEMICAL INVESTIGATION OF QUADRUPLET CODONS DECODING. Yan Chen, Nanxi Wang, Jiantao Guo, Yanmin Wan, Zhe Yuan, Qingsheng Li, Xinyuan He, and Wei Niu (abstract)

10:40 BACTERIAL-DERIVED OUTER MEMBRANE VESICLES AS A NANOCARRIER IN A NOVEL ORAL GENE DELIVERY SYSTEM. Lily Foley, Kari Heck, and Angela K. Pannier (abstract)

11:00 PRODUCTION OF HIGHLY DIVERSE LASSO PEPTIDE VARIANTS FROM A SINGLE BIOSYNTHETIC PATHWAY. Kelly S. Johnson, Ethan Hills, and Benjamin M. Brandsen (abstract)

11:20 ACRYLAMIDE CHARACTERIZATION TO BE USED IN THE ELUTION AND CONCENTRATION OF LAMBDA CONCATEMER DNA MOLECULES Samantha Rau, Alex Larsen, and Kristy Kounovsky-Shafer (abstract)

11:40 SATB1 FORMS HOMODIMERS INDEPENDENT OF DNA. Kade Wehrs and Brett Schofield (abstract)

12:00 **LUNCH**

1:00 **BUSINESS MEETING** https://unl.zoom.us/j/97870996278
Nebraska Academy of Sciences (all members)
State of the Academy
Awards Ceremony
Vote by NAS members on Revisions to NAS Constitution
Comments from Members-at-Large

1:30-2:30 **MAIBEN LECTURE** https://unl.zoom.us/j/9289316099
Dennis Ferraro, *Reflections of a Nebraska Herpetologist*

MORNING SESSION – B1

7:45 ZOOM Session opens for participants to join https://creighton.zoom.us/j/98206321200

8:00 WELCOME

8:05 5Â€™UTR STRUCTURAL ANALYSIS OF NEUROTROPIC AND NON-NEUROTROPIC STRAINS OF ENTEROVIRUS D68. Pranav Ojha (abstract)

8:25 PROTEIN RELATED TO ALZHEIMER'S DISEASE PLAYS A ROLE IN ZIKA VIRUS INFECTION. Delaney Villarreal and Luwen Zhang (abstract)

8:45 ANALYSIS OF MITOCONDRIAL EFFICIENTY BETWEEN NORTH AMERICAN YAK MITOTYPES. Leah K. Treffer, Renae L. Sieck, Anna M. Fuller, and Jessica L. Petersen (abstract)

9:05 HOMODIMERIZATION OF SATB1 AND HETERODIMERIZATION OF SATB1 AND SATB2 PRIOR TO NUCLEAR IMPORT. Grace Su and Brett Schofield (abstract)

9:25 CHEMICAL ATTRACTION OF TICKS (*PARASITIFORMIS: IXODIDAE*) TO DECOMPOSITION VOLATILE ORGANIC CHEMICALS. Gwyneth Velasco and Amanda Roe (abstract)

9:45 EVOLUTION OF A SUBSET OF NUCLEAR rRNA INTRONS IN THE LICHEN *PHYSCIA*. Rebecca Meusch and Dawn M. Simon (abstract)

10:00 **BREAK**

MORNING SESSION – B2

10:20 COMPARING THE COURSHIP RITUALS AND SEXUAL CHARACTERS OF TWO SISTER SPECIES OF *SCHIZOCOSA* WOLF SPIDERS. Seth Griger, Rowan McGinley, and Eileen A. Hebets (abstract)

10:40 DETERMINING THE MECHANISM OF ACTION OF AN ANTI-SCHISTOSOMAL COMPOUND. Caleb Sandall, and Paul H. Davis (abstract)

11:00 EVOLUTION OF INFLUENZA VIRUS MATRIX 2 PROTEIN. Aime V. Nishimwe, and Hideaki Moriyama (abstract)

11:20 SYNTHESIS, REACTION KINETICS AND ANTIMICROBIAL EVALUATION OF 1,2,3- TRIAZOLE-CONTAINING PHENANTHRIDINES. Lindsey R. Theut and James T. Fletcher (abstract)

11:40 DENDRITIC CELLS DISPLAY SEX-SPECIFIC DIFFERENCES IN ABILITY TO MOUNT IMMUNE RESPONSE TO PEANUT. Tyler Shaner, McKenna S. Vininski, and Joseph J. Dolence (abstract)

12:00 **LUNCH**

1:00 **BUSINESS MEETING** https://unl.zoom.us/j/97870996278
Nebraska Academy of Sciences (all members)
State of the Academy
Awards Ceremony
Vote by NAS members on Revisions to NAS Constitution
Comments from Members-at-Large

1:30-2:30 **MAIBEN LECTURE** https://unl.zoom.us/j/9289316099
Dennis Ferraro, *Reflections of a Nebraska Herpetologist*

MORNING SESSION – C1

7:45 ZOOM Session opens for participants to https://unk.zoom.us/j/98703815945

8:00 WELCOME

8:05 ANALYSIS OF JEG-3 CELL INFLAMMATION AND ENDOPLASMIC RETICULUM STRESS RESPONSE AFTER HOG DUST EXPOSURE. Jenna Whitmore, Philma Glora Muthuraj, and Sathish Kumar Natarajan (abstract)

8:25 MICROBIOME CHARACTERIZATION OF AN EXTREMOPHILIC POPULATION OF WETSALTS TIGER BEETLE, *CICINDELIDIA HAEMORRHAGICA* FOUND IN YELLOWSTONE NATIONAL PARK. Nicole McPhillips, Jennifer Grove, and Phyllis Higley (abstract)

8:45 EXAMINATION OF SEX-SPECIFIC DIFFERENCES IN TYPE 2 INNATE LYMPHOID CELLS, PLASMABLASTS, AND T FOLLICULAR HELPER CELLS FOLLOWING PEANUT EXPOSURE. Leigh-Anne Lehmann, McKenna S. Vininski, and Joseph J. Dolence (abstract)

9:05 MOLECULAR SUBCLONING, EXPRESSION AND FUNCTIONAL CHARACTERIZATION OF HUMAN TRANSFORMING GROWTH FACTOR BETA TYPE 1 TO DECIPHER THE ROLE IN ANTIRETROVIRAL PHARMACOLOGY. Gabriella Moore, Shetty Ravi Dyavar, and Anthony T. Podany (abstract)

9:25 HIGH PREVALENCE OF PRE-EXISTING SEROLOGICAL CROSS-REACTIVITY AGAINST SEVERE ACUTE RESPIRATORY SYNDROME CORONAVIRUS-2 (SARS-COV-2) IN SUB-SAHARAN AFRICA. Phoebe Peña, Salum Lidenge, Charles Wood, and For Yue Tso (abstract)

9:45 DECREASED TRICARBOXYLIC ACID (TCA) CYCLE IN *STAPHYLOCOCCUS AUREUS* INCREASES SURVIVAL TO INNATE IMMUNITY. Trenten Theis, Trevor Daubert, Kennedy Kluthe, and Austin Nuxoll (abstract)

10:00 **BREAK**

MORNING SESSION – C2

10:20 INVESTIGATION OF AGE-RELATED PATTERNS OF IMMUNE FUNCTION IN HONEYBEES. Nicole Haen and Carol Fassbinder-Orth (abstract)

10:40 CREATION OF AN INFLUENZA B EPIGRAPH VACCINE. Kristine Hoagstrom, Leigh Jahnke, and Eric Weaver (abstract)

11:00 INVESTIGATION OF MXB AS A RESTRICTION FACTOR OF CYPRINID HERPESVIRUS-3. Halle Weise and Dane M. Bowder (abstract)

11:20 A NOVEL LONG NON-CODING RNA ALTERS MICROGLIAL RESPONSE IN VIRAL MODEL OF MULTIPLE SCLEROSIS. Olivia L. Burleigh and Annemarie Shibata (abstract)

11:40 *IN VIVO* QUANTIFICATION OF FLIM AND SHG CHANGES ASSOCIATED WITH SKIN CANCER IN SKH1 MICE. Kelsey A. Jackson, Connor J. Kalhorn, Cecilia Myers, Thien Q. Tran, George Varghese, Daniel H. Wood, Laura A. Hansen, and Michael G. Nichols (abstract)

12:00 **LUNCH**

1:00 **BUSINESS MEETING** https://unl.zoom.us/j/97870996278
Nebraska Academy of Sciences (all members)
- State of the Academy
- Awards Ceremony
- Vote by NAS members on Revisions to NAS Constitution
- Comments from Members-at-Large

1:30-2:30 **MAIBEN LECTURE** https://unl.zoom.us/j/9289316099
Dennis Ferraro, *Reflections of a Nebraska Herpetologist*

SATURDAY, APRIL 24

MORNING SESSION – A3

7:45 ZOOM Session opens for participants to join https://unk.zoom.us/j/98565271808

8:00 WELCOME

8:05 MEASUREMENT OF CELL TRANSIT TIMES POST-CHEMOTHERAPY FOR THE PHYSICS OF CANCER. Megha Jacob, Gargee Khaparde, Ashley Abraham, Destiny Jordan, Chisom Nwakama, Sukhman Virdi, Scott Baumel, Spencer Mckinley, and Andrew Ekpenyong (abstract)

8:25 EFFECTS OF CURCUMIN ON TRIPLE NEGATIVE BREAST CANCER. Lelisse Umeta, Isioma Akwanamnye, and Ann Marie Buchmann (abstract)

8:45 EFFECT OF CURCUMIN ON GENE EXPRESSION INDUCED BY NF-KB PATHWAY IN TRIPLE NEGATIVE BREAST CANCER. Isioma Akwanamnye*, Lelisse Umeta, and Ann Marie Buchmann (abstract)

9:05 IONIZING RADIATION INDUCES EXPRESSION OF A NOVEL LONG NON-CODING RNA AND PRO-INFLAMMATORY MEDIATORS IN HUMAN NEUROBLASTOMA CELLS. Nicholas W. Mathy, Michael Mimlitz, and Annemarie Shibata (abstract)

9:45 NADH PHASOR FLIM IMAGING IN THE EARLY DETECTION OF UVA-INDUCED SKIN CANCER IN SKH1 MICE. George Varghese, Kelsey A. Jackson, Connor J. Kalhorn, Cecilia Myers, Thien Q. Tran, Daniel H. Wood, Laura A. Hansen, and Michael G. Nichols (abstract)

10:00 **BREAK**

MORNING SESSION – A4

10:20 ELASTOMER-BASED MICROFLUIDIC MIMETICS FOR THE PHYSICS OF CANCER. Sukhman Virdi, Chisom Nwakama, Destiny Jordan, Ashley Abraham, Megha Jacob, Gargee Khaparde, and Andrew Ekpenyong (abstract)

10:40 ANTI-CANCEROUS EFFECTS OF MONONAPHTHYL TRUXILLATE ON PROSTATE CANCER CELLS. Michaela Walker, Wuilian Martinez, Mahesh Pattabiraman, and Surabhi Chandra (abstract)

11:00 THE ANTIBIOTIC ACTIVITY OF THE LASSO PEPTIDE KLEBSIDIN AND ITS VARIANTS. Tyler J. Woodward, Ethan Hills, Stanley Fields, and Benjamin M. Brandsen (abstract)

11:20 THE EFFECTS OF 3 WEEKS OF AEROBIC EXERCISE IN HEAT ON FITNESS AND PGC1α IN FEMALES. Mark McGlynn, Robert Shute, Dustin Slivka, Walter Hailes, and Brent Ruby (abstract)

11:40 REPRODUCTIVE ECOLOGY OF *STUCKENIA PECTINATA*. Adam Wilson, Monroe Pruett, Neha Lamsal, Karis Choy, and Mackenzie Taylor (abstract)

12:00 RESIDUE SUBSTITUTIONS AFFECT THE SOLUBILITY PROFILE OF PRION PROTEIN PrP^C WITH DISTINCT PATHOLOGICAL SUSCEPTIBILITY BUT NOT FIBRILLOGENIC PROPENSITY. Steffany Nguyen and Patricia Soto (abstract)

12:20 **LUNCH**

MORNING SESSION – B3

7:45 ZOOM Session opens for participants to join https://unk.zoom.us/j/97443147475

8:00 WELCOME

8:05 EFFECT OF LOCAL HEAT APPLICATION DURING EXERCISE ON GENE EXPRESSION RELATED TO MITOCHONDRIAL HOMEOSTASIS. Nattie O'Reilly, Mark McGlynn, Christopher Collins, and Dustin Slivka (abstract)

8:25 FLUID SHIFTS WITH ACUTE EXPOSURE TO NORMOBARIC AND HYPOBARIC HYPOXIA. Larry Robins, Christopher Collins, and Dustin Slivka, Brent Ruby, Walter Hailes (abstract)

8:45 CONSTRAINT BASE MODELLING OF MUS MUSCULUS LUNGS. Samuel Streeter and Tomas Helikar (abstract)

9:05 THE EFFECT OF WORD LENGTH ON SPELLING REACTION TIME FOLLOWING AUDITORY PRESENTATION. Kayley Anderson, Nathan Hazel, and Maya Khana (abstract)

9:25 SCREENING AND CHARACTERIZATION OF POU4F3 TRANSCRIPTIONAL ACTIVATORS FOR HAIR CELL REGENERATION IN MICE. Joseph Frank and Jian Zuo (abstract)

9:45 GENOME-WIDE ASSOCIATION STUDY OF TINNITUS IN THE UK BIOBANK POPULATION. Madeleine Urbanek and Jian Zuo (abstract)

10:00 **BREAK**

MORNING SESSION - B4

10:20 EFFECTS OF FOOD DEPRIVATION ON ANXIETY-LIKE BEHAVIOR IN MICE. Reagan TeKolste, Sydnie Lowery, and Nicholas Hobbs (abstract)

10:40 INFLUENCE OF PARKIN W402A MUTATION IN MITOCHONDRIA WITHIN MICE: A MORPHOLOGICAL AND MORPHOMETRIC APPROACH. Daniel Estrella, Benjamin Lamberty, Steven Totusek, Kelly Stauch, and Howard Fox (abstract)

11:00 ANALYSIS OF STRUCTURAL DISORDER AND CHARGE PATTERNING INDICATE THAT THE C-TERMINUS OF THE PRION PROTEIN IN MAMMALS DRIVES AGGREGATION. Dan Irwin and Patricia Soto (abstract)

11:20 SHOLL ANALYSIS IMPLEMENTATION FOR NERVE DIEBACK: A QUANTIFICATION METHOD FOR NEURITE RETRACTION IN 3D DORSAL ROOT GANGLION EXPLANT CULTURE. Alvaro Moreno Lozano, Fei San Lee, and Rebecca A. Wachs (abstract)

11:40 CRYSTALLIZATION AND STRUCTURAL STUDIES OF PCNA-CAF-1 FUSION COMPLEXES. Rebekah Rapoza, Lucas Struble, Gloria Borgstahl, and Lynne Dieckman (abstract)

12:00 EFFECTS OF OXYGEN LEVELS AND CULTURE CONDITIONS ON THE CELLULAR METABOLISM ON SQUAMOUS CELL CARCINOMA (SCC) CELLS. Daniel H. Wood, Kelsey A. Jackson, Connor J. Kalhorn, Cecilia Myers, Thien Q. Tran, George Varghese, Laura A. Hansen, and Michael G. Nichols (abstract)

12:20 **LUNCH**

MORNING SESSION – C3

7:45 ZOOM Session opens for participants to join: https://creighton.zoom.us/j/92688828414

8:00 WELCOME

8:05 SYNTHESIS OF BIOPLASTIC USING BANANA PEELS. Meera Cao and Ganesh Naik (abstract)

8:25 CREATING A COMBINATION DRUG THERAPY AGAINST THE CHRONIC STAGE OF *TOXOPLASMA GONDI.* LeeAnna M. Lui, Austin G. Sanford, Braydon Dreher, Andrew J. Neville, and Paul H. Davis (abstract)

8:45 INVESTIGATING THE ROLE OF NOSTRILL EXPRESSION IN A TMEV-IDD MOUSE MODEL OF MULTIPLE SCLEROSIS. Arthur Segismundo, Nicholas Mathy, Kristen Drescher, and Annemarie Shibata (abstract)

9:05 ANALYSIS OF A PUTATIVE FRAMESHIFTING RNA STRUCTURE FROM THE FUNGUS AGARICUS BISPORUS (MUSHROOM). Taylor Burke, Logan Baumberger, Garrett Soukup, and Juliane Strauss-Soukup (abstract)

9:25 EXPLORING ANTI-SCHISTOSOMA ANALOG SA01. Sarah Alsuleiman, Thomas Schulze, Andrew Neville, and Paul H. Davis (abstract)

9:45 MECHANISM OF INTERACTION BETWEEN GENE SILENCING PROTEINS USING X-RAY CRYSTALLOGRAPHY. Keely Orndorff and Lynne Dieckman (abstract)

10:00 **BREAK**

MORNING SESSION – C4

10:20 SYNTHESIS AND ANTIMICROBIAL EVALUATION OF MULTIVALENT 1,2,3-TRIAZOLIUM SALTS. Laura Cogua and James T. Fletcher (abstract)

10:40 CHARACTERIZING HIGH PERSISTER PHENOTYPES IN *STAPHYLOCOCCUS EPIDERMIDIS* CLINICAL ISOLATES. Kaitlyn Pineda, Seth Ostdiek, Amber Menard and Austin Nuxoll (abstract)

11:00 CHARACTERIZATION OF VIRUS INFECTION OF *PSEUDOMONAS FLUORESCENS* USING RNA SEQUENCING. Lavanya Uppala and William Tapprich (abstract)

11:20 ANALYSIS OF BACTERIAL GROWTH IN THE PRESENCE OF GLMS RIBOSWITCH LIGAND ANALOGS. Alexandra Van Cleave, Clare Weber, and Juliane Soukup (abstract)

11:40 SEX HORMONES PLAY A CRITICAL ROLE IN MODULATING THE IMMUNE RESPONSE TO PEANUT. McKenna S. Vininski and Joseph J. Dolence (abstract)

12:00 USING SINGLE CELL TRANSCRIPTOMICS TO DEDUCE THE EFFECTS OF A NOVEL ANTI-PARASITIC COMPOUND. Ryan Chapman, Andrew Neville, Thomas Schulze, and Paul Davis (abstract)

12:20 **LUNCH**

BIOLOGICAL & MEDICAL SCIENCES ABSTRACTS

EFFECT OF CURCUMIN ON GENE EXPRESSION INDUCED BY NF-KBPATHWAY IN TRIPLE NEGATIVE BREAST CANCER

Isioma Akwanamnye, Lelisse Umeta, and Ann Marie Buchmann, Departmentof Physical and Life Sciences, Chadron State College, Chadron, NE 69337

Triple negative breast cancer (TNBC) accounts for approximately 13 percent of all breast cancer cases. TNBC is characterized by lack of expression of estrogen receptors (ER), progesterone receptors (PR), and human epidermal growth factor receptors (HER2) making conventional hormonal therapies less effective in treating this aggressive form of breast cancer. Therefore, *de novo* treatment models are necessary to targeting different pathway involved in triple negative breast cancer. Curcumin, a major component of the spice turmeric extracted from the plant *Curcuma longa,* has long been recognized for its medicinal propertiesincluding the inhibition of cancer cell proliferation. The objective of this study was to investigate the effects of curcumin in inhibiting NF-kB pathway in triple negative breast cancer cells focusing on the expression of NF-kB responsive genes. MDA-MB 231 TNBC cells were treated with different concentrations of curcumin (4μM, 8μM, 12μM & 16μM dissolved in DMSO) at 24 & 48-hours intervals and compared to a DMSO-treated control group. RNA was extracted from cells and converted to cDNA using reverse transcriptase protocols. Real-time quantitative PCR (RT- qPCR) was used to quantify expression of different genes using GAPDH as a housekeeping gene control for each treatment concentration. The $2^{-\Delta\Delta CT}$ method was used to analyze the relative changes in gene expression from RT-qPCR. After treatment with curcumin for 24 -48 hours, the expression levels of cyclin D1 and c-myc at different concentrations (4μM, 8μM, 12μM & 16μM) were decreased compared with those of the control group. These results indicate that curcumin is able to decrease expression of genes induced by the NF-kB pathway in TNBC.

TESTING THE VIABILITY OF A YEAST INSULATOR ASSAY FOR SCREENING MAMMALIAN PROTEINS

Trevin Alberts and Brett Schofield, Department of Biology, Doane University, Crete, NE 68333

Tightly compacted regions of DNA called heterochromatin consist largely of repeated DNA sequences and silenced genes. It is caused by specific histone modifications such as H3K9me3 which have the propensity to spread to adjacent regions of DNA. This causes genesto become silenced by the position effect when they are moved close to a region of heterochromatin. Insulator elements and proteins serve to limit the spread of these repressive chemical markers. While the identity of insulator proteins in simple eukaryotic cells are well understood, only one mammalian protein - CTCF - has been shown to possess insulator activity. Here we test the feasibility of using a yeast-based assay to screen candidate mammalian proteins for insulator activity. The assay directs chimeric proteins to a region between a telomere and a sub-telomeric gene that is usually silenced by the position effect. Candidate proteins with insulator activity will shelter the downstream gene from the heterochromatin, causing it to activate. However, it is unclear whether mammalian proteinswill retain insulator properties in a yeast cell. We have tested four orthologs of CTCF usingthis assay, none of which show insulator activity. These results suggest that this yeast assay may not be an efficient way to screen mammalian proteins for insulator activity.

COMPARATIVE ANALYSIS OF THE GENETIC REQUIREMENTS FOR FILAMENTATION IN DIVERGENT C. ALBICANS STRAINS

Akram Almansob, Elias Smith, Jill Blankenship, Lizbeth Basilio**,** Department of Biology, University of Nebraska at Omaha, Omaha, NE 68105

Candida albicans is a fungal pathogen that persists in the human gastrointestinal or genital tract that can infect other organs in the host's body (Azadmanesh et al. 2017). When *C. albicans* proliferates, it can cause invasive mucosal infections; the mortality rate associated with this clade of C. albicans can be as high as 40% in vulnerable populations (Pfaller & Diekema, 2007). One of the main contributions to its lethality is associated with itsability to switch between a yeast form and a filament form. According to previous work, this switch allows it to have distinct cell surface proteins by changing the composition of the cell wall (Azadmanesh et al. 2017). With this change a sticky filament is formed and *C. albicans* is able to attach to areas deep within the body. This also allows it to infect such medical appliances as pacemakers or ports (Azadmanesh et al 2017). Previous research in the lab shows that the TSC11 gene plays a role in *C. albicans* filamentation in the SC5314 derived strain (Azadmanesh et al. 2017). This study will use a transient CRISPR-CAS9 to delete the TSC11 gene in 5 isolates from distinct C. albican clades (Min, et al. 2016). This deletion of TSC11 will highlight whether TSC11 has the same effects on filament formation in our clinical strains as observed in the SC5314 derived strains (Azadmanesh et al 2017). If we observe the same pattern on filamentation as previously noted, it will mean that TSC11 may be a potential target for anti-filamentation therapies (MIN, et al. 2016). If the knockout of the TSC11gene has no effect on filamentation in our clinical strains, this will mean the gene's role is limited in thisclade; this will suggest that the role of the TSC11 gene is dependent on the genetic background.

EXPLORING ANTI-SCHISTOSOMA ANALOG SA01

Sarah Alsuleiman, Thomas Schulze, Andrew Neville, and Paul H. Davis
Department of Biology, University of Nebraska at Omaha, 6001 Dodge St, Omaha,NE 68182

Schistosomiasis, a commonly neglected tropical disease, is a waterborne parasitic worm infection able to infect through direct skin penetration. This disease affects approximately 270 million people worldwide and ranks only second to malaria as a leading infectious disease. Although some possible alternatives are emerging, currently, the most effective drug treatment ispraziquantel (PZQ). However, PZQ is only effective against the adult stage of the worm, allowing juvenile worms to progress in the infection. Additionally, Schistosoma worms are developing resistance to this drug as reduced efficacy has been noted. Thus, the need for drug discovery and testing is increased. SA01, a worm clearing derivative of aryl hydantoin Ro 13-3978 is being investigated to treat Schistosomiasis. Previous data points to the compound acting on the host's immune system as opposed to directly on the worms. Single cell transcriptomics was conducted, and a notable change was significant increase in neutrophil population. Furthermore, there was significant changes in the erythroidal lineage indicative of splenicerythropoiesis, which is also consistent with an inflammation type response. Our work focuses on investigating the immunomodulatory mechanism of SA01 treatment.

THE EFFECT OF WORD LENGTH ON SPELLING REACTION TIME FOLLOWING AUDITORY PRESENTATION

Kayley Anderson, Nathan Hazel, Maya Khana, Ph.D., Department of Psychological Science, Creighton University, Omaha, NE, 68178

The cognitive processes underlying the transition from auditory presentation to motor output in spelling have been well studied. However, when a person generates the motor program (i.e., the key press sequence) of spelling is still being debated. This study aims to explore the effect of word length on the reaction time to first key press in order to better understand when this programming may take place. Participants included undergraduate students ages 18-24 who completed 2,000 trials. By using the megastudy approach in which participants complete a very large number of trials, we can perform regression analyses that allow us to explore the relative influence of word features, such as length, on spelling performance. Within each trial, participants first heard a word ranging in length from 3 to 8 letters and then typed the word as quickly and accurately as possible. Results indicate a significant correlation between number of characters in a word and time to first key press. This suggests that at least some of the motor programming of spelling occurs before the plan is enacted. This effect seems to be independent of word ambiguity defined here as an auditorypresentation with multiple correct spellings. Results showed similar reaction times to first key press for both ambiguous and unambiguous words both broadly and at each character level. This seems to suggest that the time spent determining which form of the word will be used is less relevant to overall timing of motor planprogramming than might be thought.

ANALYSIS OF A PUTATIVE FRAMESHIFTING RNA STRUCTURE FROM THE FUNGUS *AGARICUS BISPORUS* (MUSHROOM)

Taylor Burke, Logan Baumberger, Garrett Soukup, Department of Biomedical Sciences Chemistry, Creighton University Medical School, Omaha, NE 68729, Juliane Strauss- Soukup, Department of Chemistry, Creighton University, Omaha, NE 68729

Riboswitches are segments of non-coding RNAs that bind specifically to cellular metabolites, such as the polyamine spermine, and undergo a conformational change that results in a change in gene expression. Riboswitches are key components of the prokaryotic genomes they regulate key metabolic pathways. The crucial role of riboswitches in metabolism allows for the development of potential antibiological and antineoplastic agents. While bacterial riboswitches are well characterized in literature, the existence of eukaryotic riboswitches remains relatively unexplored. One putative eukaryotic riboswitch is the Ornithine Decarboxylase Antizyme (OAZ) RNA involved in polyamine synthesis. Polyaminesare essential organic molecules that interact with DNA, RNA, and proteins and are involved inmany cellular processes. The presence of sufficient polyamines stimulates a conformational change in the RNA that results in translation of the Ornithine Decarboxylase Antizyme (OAZ) protein. Once OAZ is produced, it binds to ornithine decarboxylase and targets it for degradation. Thus, the putative frameshifting OAZ RNA provides feedback inhibition. Confirming whether a change in gene expression occurs in a polyamine-dependent manner will provide evidence that the OAZ RNA exhibits characteristics of a riboswitch. To determine whether a predicted frameshifting element in the fungus *Agaricus bisporus* exhibitscharacteristics of a riboswitch, dual luciferase reporter assays (DLRA) were used

to indicate that the putative riboswitch exhibits a conformation change upon binding specifically with spermine. Other polyamines were also tested to assess specificity. Preliminary DLRA results indicate a 2.5-fold increase in *Photinus* versus *Renilla* luciferase activity in the presence of spermine, a 1.3 fold increase in the presence of pentaamine, a 1.4 fold increase in the presenceof N,N'-Bis(3-aminopropyl)-1,3-propanediamine (Analog A), and a 1.7 fold increase in the presence of N,N'-Bis(2-aminoethyl)-1,3-propanediamine (Analog C). The resulting robust change in gene expression in the presence of spermine, indicates that the OAZ RNA exhibits riboswitch behavior. Future directions include validating the riboswitch behavior of OAZ RNA in other eukaryotes such as *Crassostrea gigas* (oyster) and *Mus musculus* (mouse).

A NOVEL LONG NON-CODING RNA ALTERS MICROGLIAL RESPONSE INVIRAL MODEL OF MULTIPLE SCLEROSIS

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Multiple Sclerosis (MS) is an autoimmune disease that causes demyelination in the central nervous system. The exact mechanisms and cause of this disease are still largelyunknown; however, one leading hypothesis is that disease progression may be triggered by certain viral infections. Theiler's murine encephalomyelitis virus (TMEV) is a single-stranded RNA cardiovirus and is commonly used to model MS. Long non-coding RNAs (lncRNAs) are atype of RNA that are not transcribed into protein and are at least 200 nucleotides long. LncRNAsmodulate diverse cellular processes and were recently discovered to play a key role in inflammation. The molecular mechanisms of lncRNAs in inflammatory neurodegenerative disorders such as MS are currently unknown. We hypothesized that after TMEV infection in microglia, certain lncRNAs are differentially expressed and alter the viral load of infected microglia. To test our hypothesis *in vitro*, we infected a murine microglial cell line (BV2), primary microglia, and FBV/nJ mice with the DA strain of TMEV. Following infection, RNA from BV2 cells, primary microglia, and cortical tissue from infected mice was isolated for RT-PCR analysis. Functional studies using knockdown or overexpression of lncRNAs were performed in BV2 cells and primary murine microglial cells. TMEV infection of BV2s, primarymicroglia, and FVB/nJ mice significantly upregulated expression of lncRNA Nostrill comparedto controls. UV-inactivated TMEV failed to induce lncRNA-Nostrill in *in vitro* experiments. Knockdown of lncRNA-Nostrill significantly increased TMEV viral load in BV2 cells while overexpression of lncRNA-Nostrill significantly reduced TMEV viral load. TMEV infection inprimary microglia, significantly upregulated pro-inflammatory cytokines IL-1ß and TNF-α by3.2-fold and 5.2-fold, respectively. Interestingly, there was also an upregulation of the anti- inflammatory cytokine IL-10 by 10.3-fold. The induction of lncRNA-Nostrill in response to TMEV infection likely contributes to antiviral defense in microglia. Further work will investigate the underlying molecular mechanisms of lncRNA-Nostrill, its contribution to viral defense in the central nervous system, and its potential role in the development of a model for MS. Funding provided by Creighton University 2020 Haddix President's Faculty Research Fund.

SYNTHESIS OF BIOPLASTIC USING BANANA PEELS

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Plastic is an incredible material, however, improper disposal of the plastics ends up in our environment, resulting in its accumulation in oceans and landfills and cause deaths of millions of animals annually. Bioplastics have been on the rise due to the dwindling supply of fossil fuel and the drastic consequences of carbon pollution. There have been a variety of sourcesfor bioplastic ranging from cassava, potato, sugarcane, and food waste. The research project focuses on one of the cheapest and easily accessible food wastes: banana peels. With millions of tons being thrown away, banana peels have high potential in creating cheaper, sustainable bioplastic. The biopolymersynthesis experiments were carried out using banana peels. First, thepeels were diced into small squares followed by its dissolution in glacial acetic acid as a solvent.The mixture is boiled, dried, and pureed to form a paste. The paste is hydrolyzed in presence ofglycerol, and cornstarch. The glycerol that acts as a plasticizer and it helped to create a thin biopolymer. After standardizing the synthesis process, the plan is to test the tensile strength, water absorption, and biodegradability, The physical and mechanical properties of the biopolymer will be compared with the standard bioplastics.

USING SINGLE CELL TRANSCRIPTOMICS TO DEDUCE THE EFFECTS OF A NOVEL ANTI-PARASITIC COMPOUND

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Schistosoma mansoni is a waterborne infectious parasite that causes an infection known as schistosomiasis and infects over 230 million individuals annually. The disease is prevalent in countries with high rates of poverty. As there is only one drug available, the emergence of a resistant strain could be deleterious, and it is known that the current drug doesnot affect the juvenile stage, significantly hampering eradication efforts. Our lab is working on a novel antischistosomal compound that shows promising efficacy in a mouse model, but not against the worm directly. We are investigating the mechanism of action of this compoundusing single-cell RNA-seq. This technique allows us to examine gene expression at the level of individual host cells. Our goal is to understand more about the mechanism by which this drug interacts with the host immune system.

BIOMEDICAL APPLICATION AND BIOCHEMICAL INVESTIGATION OF QUADRUPLET CODONS DECODING

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Unnatural amino acids (unAAs) mutagenesis is a powerful tool to introduce novel properties into proteins. Recently, an increasing number of studies were reported to employ quadruplet codons to encode unAAs. We and others have demonstrated that the quadruplet decoding efficiency could be significantly enhanced by engineering tRNAs. The tRNA variants derived from directed evolution based on the bacterial platform were confirmed to efficiently decode a UAGA quadruplet codon in mammalian cells. With the evolved tRNA variant, we

successfully demonstrated that the replication of Human Immunodeficiency Virus type 1 (HIV-1)can be tightly controlled by the decoding of a genomically embedded UAGA codon with a unAA, which can be applied to the development of a safer HIV-1 vaccine. To further expand the application of the quadruplet codons, it is crucial to find a strategy to improve decoding efficiency. We seek to identify recording signals embedded in the mRNA sequence that can provide general design rules for efficient quadruplet codon decoding and help us understand the +1 frame shifting mechanism.

SYNTHESIS AND ANTIMICROBRIAL EVALUATION OF MULTIVALENT 1,2,3-TRIAZOLIUM SALTS

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Triazolium salts are quaternary ammonium compounds (QACs) that have been shown to exhibit antibacterial and antifungal properties, which vary depending on the identity of their substituents. The purpose of this study was to evaluate the antimicrobial activity of triazolium QACs as the charge of the salt is varied, and to optimize potency through variation of aryl substitution patterns. Aryl azide compounds were synthesized with varying methyl, methoxy, n-butyl, t-butyl and chloro substituents. These aryl azides were reacted with ethynylbenzene, m-diethynylbenzene, p-diethynylbenzene and 1,3,5-triethynylbenzene using a base-catalzyed click reaction to form 1,5-disubsituted-1,2,3-triazole analogs. A library of triazolium salts was prepared by the mono, di and tri-substitution of benzyl bromide, 1-bromobutane or 1-iodobutane groups at the N3 position of each triazole ring. A total of 180 molecules were made and analyzed for antimicrobial properties by performing microdilution minimum inhibitory concentration (MIC) assays against Gram-positive bacteria, Gram-negative bacteria and yeast. MIC activity indicated a maximum potency of 0.2 μM against Gram-positive bacteria, 0.8 μM against Gram-negative bacteria and 0.4 μM against yeast. MIC potency was enhanced by the presence of benzyl bromide on the N3 position and a hydrophobic chain on the N1-phenyl group. Disubstituted salts with meta connectivity proved to have the highest MIC potency. No significant difference was found in between equivalent bromide and iodide salts. Details regarding the synthesis, characterization, and antimicrobial assays of these compounds will be presented. This publication was made possible by grants from the National Institute for General Medical Science (NIGMS) (5P20GM103427), a component of the National Institutes of Health (NIH), and its contents are the sole responsibility of the authors and do not necessarily represent the official views of NIGMS or NIH.

INFLUENCE OF PARKIN W402A MUTATION IN MITOCHONDRIA WITHIN MICE: A MORPHOLOGICAL AND MORPHOMETRIC APPROACH

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Parkinson's Disease (PD) affects 60,000 Americans annually. To improve treatments, itis essential we first have a better understanding of the disease and its characteristics. The PINK1/PARKIN pathway is believed to be an essential tool that cells utilize for mitochondrial repair. It is hypothesized that the disruption of this pathway is correlated with the formation of PD-like symptoms. Mutations in the genes involved can alter the pathway, which could cause disruption of mitochondrial physiology. Mutations of PINK1 & PARKIN have been documented

but an understanding of their effects is lacking. Identification of the mutated proteins within cells is important to then be able to study each one and the characteristics and behaviors that will express in the protein itself. This study focuses on the mutation PARKIN W402A. The mutation is hypothesized to produce an overactive form of PARKIN within cells that could potentially alter the PINK1/PARKIN pathway. This project used morphological images of mitochondrial networks to get qualitative measurements and performed morphometricmeasurements using Mitograph^{TM} software to test for Mitochondrial response to specific stressors. This behavior could not be confirmed due to the low N-value that was used in this project so more exhaustive research is needed and this accounts for only one of many mutationsthat should be examined for impact on mitochondrial morphology. Continuing research is beingconducted to increase the sample size and test it with additional treatments. This research was made possible by grants from the National Center for Research Resources (5P20RR016469) andthe National Institute for General Medical Science (NIGMS) (8P20GM103427), a component by the National Institutes of Health (NIH).

BACTERIAL-DERIVED OUTER MEMBRANE VESICLES AS A NANOCARRIER IN ANOVEL ORAL GENE DELIVERY SYSTEM

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The oral route is a preferred method for administration of non-viral gene delivery vehicles due to ease of use, high patient compliance, and the large target surface area exposedin the gastrointestinal tract. Potential applications for oral non-viral gene delivery systems include gene therapy and nucleic acid-based vaccination. To combat the obstacles posed by the oral route, we are designing a novel delivery system that employs bacteria-derived outer membrane vesicles (OMVs) to transport plasmid DNA. OMVs are a naturally occurring material in the human gut and formed from the outer membrane of gram-negative bacteria through the blebbing. OMVs are an important tool for host-bacteria communications and havebeen shown to cross the mucosal membrane, interact with intestinal epithelial cells, and modulate the host immune response. To create this novel delivery system, we have loaded plasmid DNA into OMVs using extrusion, resulting in the formation of DNA-loaded OMV nanocarriers (DNA-OMV NCs). Optimization of the extrusion loading process showed that both the resting period conditions after extrusion and the DNA:OMV ratio impacted the loading efficiency of DNA into OMVs.The highest loading efficiency was accomplished with two rest periods at 37°C and using a ratio of 2:1 DNA:OMV; these conditions yielded an average DNA loading efficiency of 21.5% ± 9.3%. DNA-OMV NCs then successfully mediated transfection of HEK 293T cells *in vitro*. Taken together, these data implicate DNA-OMV NCs as a promising new vehicle for oralgene delivery that can protect a DNA payload.

SCREENING AND CHARACTERIZATION OF POU4F3 TRANSCRIPTIONAL ACTIVATORS FOR HAIR CELL REGENERATION IN MICE

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Atoh1 and Pou4f3 are two genes well-known for their involvement in mammalian hair cell development. Either Atoh1 overexpression alone or Pou4f3 overexpression alone can support the direct transdifferentiation of nonsensory supporting cells to immature hair cells (HCs). Our

previous work has shown that in adult mouse cochleae, Atoh1 overexpression alone results in ~5new HCs per cochlea, Pou4f3 overexpression alone results in ~25 new HCs per cochlea,and that combining Atoh1 and Pou4f3 overexpression vastly enhances the conversion rate, resulting in ~160 new HCs per cochlea. To identify small molecules that can promote HC regeneration, we collaborated with Novartis to screen over 45,000 compounds for POU4F3 activation in ourhuman POU4F3 promoter-driven dual-luciferase reporter HeLa cell line. From this screen, we found 86 small molecules that significantly increase POU4F3 transcriptional activity, 12 of which are known for their mechanisms of action. Our top compounds significantly increase cochlear Pou4f3 mRNA levels when delivered transtympanically in adult mice. One of these hits, C18, facilitates Atoh1-mediated conversion of supporting cells to hair cells in neonatal cochlear explants. Preliminary findings suggest that transtympanic injection of C18 increases Pou4f3 expression in supporting cells of adult wild type mice and potentially facilitates SC-to-HC conversion. Therefore, we have identified small molecule Pou4f3 agonists that may be therapeutically beneficial for cochlear hair cell regeneration in adult mammals.

COMPARING THE COURSHIP RITUALS AND SEXUAL CHARACTERS OF TWO SISTER SPECIES OF *SCHIZOCOSA* WOLF SPIDERS

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Geographic separation can be one mechanism that leads to evolutionary divergence in traits among populations. This divergence can eventually lead to reproductive isolation. If previously separated populations then become reunited, natural selection is predicted to increase the reproductive isolation between them through a process termed reinforcement. This study tests for the presence of reinforcement in two sister species of wolf spider in the genus*Schizocosa*. In particular, it examines the degree to which secondary sexual traits are divergentin sympatric (overlapping) and allopatric (non-overlapping) populations of *Schizocosa stridulans* and *S. uetzi.* These two wolf spider species share a similar habitat, that of the forestsof southeast North America. Males of both species have similar secondary sexual characters byway of darkened sections of their first pair of legs (forelegs). The presence of dark pigment on forelegs of mature males is considered a form of ornamentation. The courtship behavior of the males of *S. stridulans* and *S. uetzi* consists of stridulation of the spiders' pedipalps, followed byflashy movements of the ornamented legs. Initial observations suggest that there is variation among and within populations of these sister species with respect to both their foreleg coloration and their courtship movements. Assuming that these ornaments and behavior are relevant to preventing matings between the two species, we expect that the ornamentation and courtship movements stand out more in areas where both species overlap in space and time. This study aims to test this prediction – i.e. that sister species have greater differences in their displays if they live in the same area. If true, we expect that populations of *S. stridulans* that live among *S.uetzi* will produce more distinct displays compared to an isolated population of *S. stridulans*. Totest this, we quantified the ornamentation of male *S. stridulans* and *S. uetzi* by taking measurements of the legs of males from three populations – (i) allopatric *S. stridulans,* (ii) sympatric *S. stridulans,* and (iii) allopatric *S. uetzi*. We also quantified aspects of the dynamic visual display from males of all three populations by analyzing videos of courting males. In particular, we measured the speed of movement, range of motion, and duration of leg movement.We will discuss our results in terms of the degree of overlap

observed in both ornamentation andmovement displays between *S. stridulans* and *S. uetzi* as well as between the allopatric and sympatric populations of *S. stridulans.*

INVESTIGATION OF AGE-RELATED PATTERNS OF IMMUNE FUNCTION IN HONEYBEES

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Colony Collapse Disorder (CCD) is an abnormal phenomenon where a large number of worker bees disappear from the colony leading to abrupt colony loss. The aging process of worker bees directly relates to the longevity of the colony and its health and can be measured through the use of various physiological parameters that change with age. One example is the phenoloxidase system, which is an important defense found in invertebrates leading to the melanization of pathogens. To better understand the age-related patterns of honeybees we investigated their immune function through a phenoloxidase assay. Pupae, Hatchling, Nurse, Guard, Forager, and Drone age classes of Honeybees were collected from different hives. Thethoraxes of each bee were weighed and homogenized in PBS. We then measured and normalized the phenoloxidase activity. Young honeybees, larvae and hatchlings, showed a limited amount of phenoloxidase activity. The young adult honeybees, nurses and guards, showed a 1580% increase in phenoloxidase activity. As the honeybees age to foragers and drones, the level of phenoloxidaseactivity decreases by 26% and 78% respectively. Our results suggest that phenoloxidase is closely related to the age of the working class of honeybees.

NOVEL UNIVERSAL INFLUENZA B VIRUS VACCINE IMMUNOGENS FOR USEAS UNIVERSAL VACCINES

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The CDC struggles to predict the upcoming influenza viruses resulting in an ineffective influenza vaccine. The 2019–2020 influenza vaccine provides an example of vaccine mismatch where the vaccine poorly matches the circulating influenza strains. We have created Influenza B Epigraph hemagglutinin (HA) immunogens that are computationally designed to select the greatest coverage of B and T cell epitopes in the natural population. Our preliminary data shows Epigraph immunogens induce superior cross-reactive antibody responses, overall T cell immunity, breadth of T cell epitopes, and protection against influenza virus. The primary goal ofthis study is to clone the influenza B Epigraph HA immunogens into DNA and Adenoviral mammalian expression systems. We will characterize these novel HA immunogens for the prevention of influenza B virus infections. Ultimately, we seek to develop novel universal influenza vaccines that provide a foundation of immunity which protects against all past, present, and future influenza viruses.

ANALYSIS OF STRUCTURAL DISORDER AND CHARGE PATTERNING INDICATE THAT THE C-TERMINUS OF THE PRION PROTEIN IN MAMMALS DRIVES AGGREGATION

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Misfolding and aggregation of the prion protein is the key event in the pathology of prion diseases. The prion protein is formed by an intrinsically disordered N-terminus and a globularly folded C-terminus. Although the prion protein is highly conserved across mammalspecies, not all mammals display the same degree of susceptibility to the disease. Our goal is to figure out whether the about 10% difference in sequence accounts for the propensity of prion protein aggregation. Our first step is to pinpoint the tendency of structural disorder. To this end, we developed a computational workflow that includes the python-based CIDER package and statistical analysis. We include a number of factors of the protein residues such as position relative to one another, positive and negative electric charge, and relative structural stability. We found no strong differences in the N-terminus of the prion protein, based on the structural indicators we tested. In contrast, the C-terminus of the prion protein shows distinct charge patterning and hydropathy depending on the mammal species analyzed.We also determined that there is a correlation to the structural stability of the N-terminus based on the percentage of asparagine, but not glutamine, residues. We propose that althoughthe N-terminus of the prion protein is disordered, the fragment does not drive prion protein aggregation. Instead, the C- terminus of the prion protein shows propensity for aggregation. However, the descriptors we used cannot explain the local effect on aggregation due to residue substitutions. To resolve this issue we plan to perform coarse grained simulations of prion protein aggregation.

IN VIVO QUANTIFICATION OF FLIM AND SHG CHANGES ASSOCIATED WITH SKIN CANCER IN SKH1 MICE

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Cancer tissue is both metabolically and architecturally distinct from healthy tissue. Metabolic behavior is changed by the demands of rapid division while collagen localization is changed bythe formation of the tumor microenvironment. Previous work with fluorescent lifetime imaging microscopy (FLIM) of NADH has developed a technique to non-invasively detect the metabolicshifts. The next step is to implement an in vivo method of quantifying architectural shifts by measuring the ratio of forward- to back-propagating second harmonic generation (SHG). This metric has been proven diagnostically relevant for cancer development in ex vivo and in vitro samples. Current efforts using these techniques involve surveilling the metabolic and architectural shifts in SKH-1 mice as a response to chronic UVA exposure and tumor development. Preliminary results indicate a lower NADH bound-to-free ratio in UV exposed skin upon tumor development. In addition, we've found higher SHG forwards-to-backwards ratio in the dermal collagen of UV exposed mice compared to sham exposed mice. This technique may show promise as a sensitive, less expensive diagnostic tool for early-stage skin cancer detection. This study was made possible by grants from the IDeA Networks of Biomedical Research Excellence (INBRE) of Nebraska and the National Institute of General Medical Science(NIGMS) (5P20GM103427), a component of the National Institutes of Health (NIH). Its contents are the sole responsibility of the authors and do

not necessarily represent the official views of INBRE, NIGMS or NIH.

MEASUREMENT OF CELL TRANSIT TIMES POST-CHEMOTHERAPY FOR THE PHYSICS OF CANCER

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The translational biomedical physics (TBP) lab at Creighton recently showed in our publication "Chemotherapy impedes *in vitro* microcirculation and promotes migration of leukemic cells with impact on metastasis," in *Biochemical and Biophysical Research Communications* (Prathivadhi et al., 2016) that Doxorubicin and Daunorubicin, commonly used anticancer drugs, stiffen cells before causing cell death. This predisposes the cells to clogging and extravasation, the latter being a step in metastasis, which contributes to a vast majority of deaths caused by cancer. We are taking further steps to discover other anti-cancerdrugs that may have similar effects. We treat myelogenous (K562) cancer cells with the drugs Nocodazole, Lenalidomide and Hydroxyurea, and then measure their mechanical properties using the microfluidic microcirculation mimetic (MMM) device, which mimics aspects of blood circulation (pulmonary microcirculation) and enables the measurement of cell mechanical properties via transit times through the device. We also measure the migration ofcells thus treated to determine the functional relevance of the MMM results. Preliminary results from MMM measurements show that Nocodazole-treated K562 cells exhibit significantly altered transit times. It is already known that Nocodazole and Paclitaxel target microtubules and cell division. However, microtubules along with F-actin and intermediate filaments determine cell mechanical properties. This work has potential to be an important contribution to the new research frontier called Physics of Cancer, which focuses on the mechanical properties of cancer cells and their role in cancer progression and metastasis.

PRODUCTION OF HIGHLY DIVERSE LASSO PEPTIDES FROM A SINGLE BIOSYNTHETIC PATHWAY

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Lasso peptides are a class of ribosomally synthesized and post-translationally modified peptide natural products that exhibit a wide range of biological activity. Their threaded lariat structure provides excellent resistance to proteases and constrains the peptide conformation, making them attractive as potential inhibitors for enzymes and protein-protein interactions. Because of the lariat structure, however, preparation of lasso peptides by traditional peptide synthesis is challenging. Here, we evaluated the potential for the biosynthetic pathway that

produces klebsidin, a lasso peptide from *Klebsiella pneumoniae*, to convert highly diverse peptide sequences into mature lasso peptides. By exploiting an intracellular expression assay in *Escherichia coli* where production of a lasso peptide leads to inhibition of cellular growth, we evaluated approximately 5,000 variants with 1-4 amino acid insertions in the lasso peptide loop region. Using biological activity as a measure for lasso peptide production, we identified more than 1,000 peptide sequences that are processed into lasso structures, highlighting the tremendous potential of the klebsidin biosynthetic pathway to produce diverse lasso peptides. In current experiments, we are evaluating the expression level and verifying the lasso structure of key variants. These results suggest that the klebsidin biosynthetic pathway will be useful for generating libraries of novel lasso peptides.

EXAMINATION OF SEX-SPECIFIC DIFFERENCES IN TYPE 2 INNATE LYMPHOID CELLS, PLASMABLASTS, AND T FOLLICULAR HELPER CELLS FOLLOWING PEANUT EXPOSURE

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The mechanism of how peanut (PN) initiates immune responses to elicit PN allergy remains limited. PN is commonly found in household dust and we have shown that PN exposure via inhalation sensitizes mice. Furthermore, how sex differences influence the development of PN- specific immune responses is unknown. This study compared male and female mice exposed to PN in a 3-day mouse model to investigate how sex differences impacted the response of lung type 2 innate lymphoid cells (ILC2s) to inhaled PN. Lungs were collected from mice after 3-day exposure to PN. Cells were stained with antibodies to identify ILC2s by flow cytometry. Interestingly, ILC2s were sensitive to sex differences as ILC2s in female PN-exposed lungs were more abundant than in male PN-exposed lungs. We also examined B and T cells found in the lungs and lung draining lymph nodes (dLN) in a 10-day mouse model. CD19+ B cells and CD3e+ T cells were severely reduced in the lungs of PN-exposed male mice at 10 days when compared to their female PN-exposed counterparts. Levels of T cells were also reduced in the dLN of PN-exposed males. Future studies will fractionate the B and T cell populations to examine whether sex differences influence the response of plasmablasts and T follicular helper cells to PN. This data suggests that testosterone plays a role in dampening PN-specific adaptive immune responses, possibly through negatively influencing ILC2s. Overall, this study provides critical insight into how sex differences could play a role in regulating PN- specific immune responses.

BACTERIOPHAGE THROUGH THE DIGESTIVE TRACT OF MAMMALS

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In the year 1928 the first antibiotic was discovered by Alexander Fleming. There are now more than 2.8 million antibiotic resistant infections every year. Currently on the market is a supplement of bacteriophage. Bacteriophage is a type of virus that kills off bacteria specific to the bacteriophage, much in a similar fashion as antibiotics. This poses a question of how effective bacteriophage is inside of the human body. To study this, *Escherichia coli* bacteriophage will be plated on multiple different media all simulating the gastric environment. The effectiveness is determined by the quantification of the bacteriophage on the different media. Hopefully, in the future, the bacteriophage will be given to pigs or mice to track the absorption rate of the

bacteriophage. By determining the effectiveness of bacteriophage in the digestive tract, one day it might be considered as an alternative to antibiotic treatments.

CREATING A COMBINATION DRUG THERAPY AGAINST THE CHRONIC STAGE OF *TOXOPLASMA GONDII*

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Toxoplasma gondii is an intracellular parasite that infects 30% of the world's population. Toxoplasmosis, the disease caused by *T. gondii* infection, causes mild cold symptoms in its host initially. Existing in its acute stage, *T. gondii* replicates and infects quickly. However, weeks after infection, the parasite transforms into a slow replicating stagethat forms within cells as cysts. In this chronic cyst stage, *T. gondii* form in the host's brain, eyes, and muscle tissue. Currently, there is no treatment for this cyst stage, which can reemerge and cause lethal toxoplasmic encephalitis. Our work suggests that a novel combination of already approved drugs significantly reduces and potentially eradicates cyst burden. Through *in vitro* tissue culture and *in vivo* murine drug studies, we examine the efficacy of this cocktail and its abilityto clear cyst burden in chronic infection models. If successful, we will be closer to creating a combinational approach with FDA approved drugs that eradicate the chronic infection of *T. gondii*.

IONIZING RADIATION INDUCES EXPRESSION OF A NOVEL LONG NON-CODINGRNA AND PRO-INFLAMMATORY MEDIATORS IN HUMAN NEUROBLASTOMA CELLS

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Neuroblastomas, tumors arising from neural crest precursors, are the third most common cancer in children. Their clinical course varies widely, from spontaneous remission to aggressive disease with metastasis. The treatment of high-risk neuroblastoma includes radiation therapy, often in combination with chemotherapy and surgical resection. Despite improvements in multimodal therapy, the survival in high-risk disease is only 50%, as compared to 15% prior to instituting a combined approach. The underlying molecular factors relating to the pathogenesisof neuroblastoma and response to therapy are still being explored. Long non-coding RNAs (lncRNAs) are a class of RNA molecules which act as key modulators of diverse cellular processes through their interactions with DNA, RNA, and proteins. While many lncRNAs have been identified to be associated with disease andmalignancies, the function of few has been elucidated, and thus lncRNAs represent new potential therapeutic targets. In this study, we hypothesized that in response to exposure ofneuroblastoma cells to ionizing radiation, significant changes in gene expression would occur, particularly in lncRNAs. We had previously identified a novel lncRNA in mice that regulates inflammation in microglia,and focused our efforts on investigating the orthologous human lncRNA.

We utilized the human SH-SY5Y neuroblastoma cell line as an *in vitro* model of neuroblastoma. Ionizing radiation was delivered using a Faxitron CellRad irradiator, with a doseof 10 Gy. 24 hours after exposure to ionizing radiation, RNA was isolated and RT-PCR was

performed to analyze changes in gene expression. We observed a significant increase in the expression of the pro-inflammatory mediator Cxcl2 in irradiated neuroblastoma cells compared to controls (3.9 fold, $p < 0.05$), which servedas a control that the cells were responding to radiation. Additionally, there was a significant increase in two out of three orthologous lncRNAs in irradiated cells as compared to control (4.4fold and 5.3 fold, $p < 0.05$). This preliminary study demonstrates that the lncRNA of interest is significantly inducedin neuroblastoma cells in response to ionizing radiation, as well as the inflammatory mediator Cxcl2.Future experiments including functional studies to knockdown or overexpress the lncRNAand test for differences in proliferation and the impact on other genes related to malignancy andinflammation. Increased understanding of the molecular factors involved in high-risk neuroblastoma may deliver new therapeutic options and improve survival rates.

THE EFFECTS OF 3 WEEKS OF AEROBIC EXERCISE IN HEAT ON FITNESS AND PGC1A IN FEMALES

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The effects of exercise training in the heat have been well documented in men. However,the effects of exercise training in the heat in women have not received as much attention. We have previously reported a blunted rise in *PGC-1α* in men after acute aerobic exercise in the heat.To determine the impact of three weeks of aerobic exercise training in the heat compared to training in room temperature on thermoregulation, *PGC-1α* mRNA response, and aerobic capacity in women. Twenty-three untrained college aged females (24±4 yearsold, 168±5 cm tall, and weighed 67.3±11.2 kg) were randomly assigned to 3 weeks of aerobic exercisetraining in either 20°C (n=12) or 33°C (n=11) environmental temperatures. VO_2max in room temperature conditions increased with training (2.57±0.35 to 2.71±0.32 $L \cdot min^{-1}$, p=0.01), but was not different between 20°C or 33°C training conditions (p=0.821). HR decreased with training (152±16 to 140±0.13 bpm, p<0.001), but was not different between 20°Cor 33°C training conditions (p=0.341). Sweat rate increased with training (0.655±0.192 to 0.775±0.212 $L \cdot hr^{-1}$, p=0.006) and was higher in 33°C (0.835±0.144 $L \cdot hr^{-1}$) than 20°C (0.605±0.132 $L \cdot hr^{-1}$, p<0.001). *PGC-1α* mRNA increased with an acute exercise bout before (1.01±0.10 to 4.96±2.08 fold, p<0.001) and after training (1.07±0.10 to 3.21±1.39 fold, p<0.001) and had a smaller response after training than before training (p=0.005). There were no differences in *PGC-1α* mRNA between groups (p=0.661). Women can increase aerobic fitness and maintain their exercise induced *PGC-1α* mRNA response in the heat equally to that of room temperature conditions. This response contrasts with the blunted *PGC- 1α* mRNA response and VO_2 max alterations previously observed in men.

MICROBIOME CHARACTERIZATION OF AN EXTREMOPHILIC POPULATION OF WETSALTS TIGER BEETLE, *CICINDELIDIA HAEMORRHAGICA* FOUND IN YELLOWSTONE NATIONAL PARK

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Yellowstone encompasses approximately 3,471 square miles, covers portions of three

states, and contains a wide array of different geographical features. These geographical features include volcanic soils, bubbling mudpots, and spewing geysers. However, one of the most studied geographical areas of Yellowstone are its thermal pools. Within these thermal regions, an extensive range of unique thermophilic life forms reside. The diverse thermophilicpopulation includes indiscernible creatures such as miniscule bacteria to observable insects such as beetles. One population of beetle, *Cicindelidia haemorrhagica* or the Wetsalts Tiger Beetle, is subjected to the extreme conditions (such as pH, temperature, and acidity) of Yellowstone's thermal pools in which most organisms would not be able to survive or thrive. It is hypothesized that these beetles may be better adapted to this environment due to a uniquemicroflora or microbiome population. Microbes have been reported to have the potential to provide beneficial services to its host but the classification of microbial genera has not been fully described for this species of beetle. Our primary focus of present has been to determine the most effective method of microbiota extraction and DNA purification from within the Wetsalts Tiger Beetle microflora. The purpose is to eventually characterize the bacterial microflora genera in two populations of beetle, one that is a known thermophile found in Yellowstone and the other in a non- extreme environment. We will then be able to compare and correlate the presence of bacterialcommunities to the adaptation of survival in the extreme Yellowstone environment. Data to be presented. This project was funded by INBRE.

MOLECULAR SUBCLONING, EXPRESSION AND FUNCTIONAL CHARACTERIZATION OF HUMAN TRANSFORMING GROWTH FACTOR BETATYPE 1 TO DECIPHER THE ROLE IN ANTIRETROVIRAL PHARMACOLOGY

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Transforming growth factor beta type 1 [TGFB1] is a known component in human biology but having too much or too little can cause a myriad of issues. Our lab focuses on pharmacokinetics of antiretroviral [ARV] therapy to treat Human Immunodeficiency Virus [HIV]. We have identified the role of TGFB1 in targeting ARV pharmacokinetics and acknowledge work showing antibody signaling in HIV reservoirs in the body. ARV therapyis consistent in the blood, but not in penetration of reservoirs. In a study conducted by Dr. Dyavar (Dyavar et al., unpublished data) TGFB1 reduces penetration of anti-HIV drugs intohuman lymphoid endothelial cells [HLECs]. To explore this, TGFB1 gene was cloned into pCI- mammalian expression vector to construct pCI-TGFB1 DNA vector. pCI-TGFB1 was characterized by a restriction enzymatic digestion and DNA sequencing. Endotoxin free pCIandpCI-TGFB1 DNA vectors were prepared to utilize in in vivo mice study.

SHOLL ANALYSIS IMPLEMENTATION FOR NERVE DIEBACK: A QUANTIFICATION METHOD FOR NEURITE RETRACTION IN 3D DORSAL ROOT GANGLION EXPLANT CULTURE

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Low back pain (LBP) affects up to 80% of the population at some point in their lifetime, with disc degeneration being highly correlated with low back pain[1]. The healthy intervertebral

disc is predominantly aneural[2]. At least 40% of the cases of chronic low back pain exhibit ingrowth of sensory neurites into deep layers of lumbar discs[2-3]. These neurites from nearby dorsal root ganglion (DRG) can be sensitized and cause chronic pain[4-6]. Therefore, we hypothesize that retracting pain-sensing neurons (nociceptors) from the disc could alleviate lowback pain. There are different compounds that can cause nerve dieback, such as lysophosphatidicacid (LPA)[9]. LPA is a glycerophospholipid derived from the lipid bilayer. LPA binds to LPA receptors, the G-protein coupled receptors on myelinating Schwann cells, then activates downstream Rho pathways to cause actin rearrangement which leads to fiber retraction[10-11]. To test LPA-induced neurite retraction, DRG explants were surgically removed from adult SpragueDawley rats, embedded ina 3D hydrogel and cultured in complete Neurobasal-A media for 30 days. LPA was applied and DRGs were imaged every three minutes for up to two hours to observereal-time neurite retraction. Results showed that 10 μM LPA induced neurite retraction within minutes. To quantify change in neurite length, maximum radial distance and traced neurite pathof 10 random neurites per DRG were performed following previously established methods using ImageJ (SimpleNeuriteTracer plugin)[12]. However, this method led to contradictory informationbetween immune-fluorescent and bright field images because tracing was not automated and onlya limited number of neurites could be feasibly quantified in a short period of time. Sholl analysis is a widely used method in neurobiology to quantify the complexity of dendritic arbors by creating concentric rings and quantifying the number of intersections and could be useful in quantifying neurite retraction[13-14]. Some of the benefits of Sholl analysis, include faster and semi-automated analysis as shown in Gensel et al. 2009 where the semi-automated method was threetimes faster than the manual method[15]. Different studies have used Sholl analysis, as a commontechnique to quantify neurite growth and morphology[15], but this method has not been used to quantify neurite retraction. The goal of this project is to optimize the Sholl analysis method foran automated higher throughput analysis for nerve dieback quantification in vitro. Further workwill explore the application of Sholl analysis in nerve dieback experiments, and solve drawbacksfound in preliminary analysis, such as reduction of background noise.

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RESIDUE SUBSTITUTIONS AFFECT THE SOLUBILITY PROFILE OF PRION PROTEIN PrP^C WITH DISTINCT PATHOLOGICAL SUSCEPTIBILITY BUT NOT FIBRILLOGENIC PROPENSITY

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Prion diseases are fatal neurodegenerative diseases that affect a variety of mammals, including humans. The hallmark of prion diseases is the prion protein: The misfolded and aggregated form of the prion protein PrPSc binds to the cellular form of the prion protein PrPC and induces the conformational conversion. Although PrPCgene polymorphisms correlate with varying degrees of susceptibility of the host to develop prion diseases, how residue substitutions modulate PrPC structural dynamics towards pathological misfolding is unknown. Deciphering such mechanism will identify potential druggable hot spots to stabilize PrPC and prevent pathological conversion. Our structural bioinformatics study focuses on the effect of residue

substitutions on the stability of the hydrophobic core of the C-terminal of PrPC. We will discuss our results in light of the correlation between structural domains, increased stability in the hydrophobic core and degree of susceptibility in different species to developing prion diseases.

EVOLUTION OF INFLUENZA VIRUS MATRIX 2 PROTEIN

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Influenza is a disease caused by the influenza virus. The influenza virus has at least four species, namely, types A, B, C, and D. Type A infects several serotypes – humans, pigs, cattle,and dogs. Types B and C infect humans and pigs. Type D infects cattle and pigs. The influenzavirus consists of several parts associated with the lipid membrane, including hemagglutinin (HA,serotype H), neuraminidase (NA, serotype N), matrix proteins 1 and 2 (M1, M2), and ribonucleoproteins (RNPs). HA and NA play critical roles in immune responses of hosts. The highly pathogenic avian influenza virus infects humans rarely; nevertheless, once infection occurs, it has a high mortality. M2 proteins are present as the virus capsid and have limited exposure to the environment. Nevertheless, M2 is very common across the virus species. Vaccination is effective in preventing infection, and anti-influenza drugs are available for use once the infection has occurred. NA inhibitors inhibit the release of the virus from cells. M2 protein inhibitors inhibit viral uncoating in cells. RNA polymerase inhibitors inhibit viral genome replication in cells. Nevertheless, the effective window of these drugs is still limited inthe early stage after infection. The development of antiviral drugs with a comprehensive effect before and after infection is still necessary. In the influenza virus, amphiphilic helices are foundat least in HA and M2. The HA and the host receptor's sugar moiety, including sialylated voltage-dependent calcium channels, initiates the entry of Influenza virus In the influenza A virus, the channel formed by the M2 protein opens and proton flows into the virus particles fromthe endosome. RNA segments associated with M1 and RNP are dissolved, and the genes are released into the host cell, as the internal acidity inside the virus increases. In M2, the protein issolely composed of the amphiphilic helices. As the infectious cycle progresses, M2 is synthesizedin host cells and interferes with proteostasis before the virus can bud. M2 is thus suitable as a drug target for its unique ion channels and interaction capabilities. In this study, gatingmechanisms of M2 proteins from four different species were investigated by the electrophysiological method, and the function of key residues were mapped on the three-dimensional structure. The cation-pi interaction among conserved amino acid residues in the amphipathic helix-bundle helped to characterize the gating mechanism of the virus, a result of adaptation to the host.

5'UTR STRUCTURAL ANALYSIS OF NEUROTROPIC AND NON-NEUROTROPIC STRAINS OF ENTEROVIRUS D68

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Enterovirus D68 is a single-stranded positive-sense RNA virus of the picornaviridae familywhich utilizes its 5' untranslated region (5'UTR) to recruit ribosome and undergo cap-independent translation. First isolated in 1962 in California, EV-D68 only had minor cases of respiratory illness until 2014. Since the summer of 2014, reported outbreaks for EV D68have been increasing with a strong association with polio-like acute flaccid myelitis (AFM).Ample evidence suggests that the 750 nucleotide long 5'UTR of enteroviruses includes the internal ribosome entry

site (IRES) which plays an important role in determining their virulence. Neurotropic strains of EV-D68 have an approximate 20 nucleotide deletion in the spacer region of their 5'UTR. Understanding the structural changes in 5'UTR of current EV D68 strains from the ones in 1962 can help determine the reason for its newly gained neurotropism. A robust secondary structure of the 5'UTR is being generated by using the SHAPE- MaP analysis. This method involves chemical modification of the 2' hydroxyl group of nucleotides in the RNA molecules based on their position and flexibility. These modified molecules are converted into cDNA to create high-quality mutational profiles (MaP), which are then subjected to massively parallel sequencing. By using computational tools like the *shapemapper2* and *superfold* to analyze the NGS data, a secondary structure ofthe 5'UTR can be generated. Elucidating novel 5'UTR secondary structures of EV D68-Fermon (1962) and EV D68- KT347251.2 (2014) strains can reveal the structural changes leading to neurotropism. These novel structure of noncoding RNAs of EVD68 can also be utilized for comparative studies of 5'UTRs between other neurotropic enteroviruses like EV71- KF312457.1 (1998), Polio Virus and non- neurotropic enteroviruses like CVB3 to find key shared structures involved in determining virulence of enteroviruses.

EFFECT OF LOCAL HEAT APPLICATION DURING EXERCISE ON GENE EXPRESSION RELATED TO MITOCHONDRIAL HOMEOSTATIS

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Previous exercise investigations suggest mitochondrial-related geneexpression is blunted in response to aerobic exercise in hot environments; however, the effect of localized heating, is unknown. Determine the impact of local muscle heating during endurance exercise on human skeletal muscle mitochondrial-related gene expression. Fourteen subjects (25±6 yrs, 177±8 cm, 78±16 kg, and VO_{2peak} peak 45±8 $ml \cdot kg^{-1} \cdot min^{-1}$) cycled with one leg heated (HOT) and the other serving as a control (CON). Skin and intramuscular temperatures were taken before temperature intervention (Pre), after 30 min of temperature intervention (Pre30), immediately after exercise (Post) and four hours after exercise(4Post). Muscle biopsies were taken from each leg at Pre and 4Post for gene expression analyses. Intramuscular temperature increased within HOT (34.4±0.69ºC to 36.1±0.51ºC, $p<0.001$) and was higher than CON at Pre30 (34.02±0.68ºC, $p<0.001$). However, Post temperatures were similar between legs (HOT 38.39±0.67ºC, CON 38.28±0.48ºC, $p=0.661$). Skin temperature increased within HOT from Pre to Pre30 (30.14±0.81ºC to 34.56±0.67ºC, $p<0.001$), was higher than CON at Post30 (30.25±1.04ºC, $p<0.001$), and remained higher than CON at Post(HOT 34.6±0.89ºC, CON 32.29±1.63ºC, $p<0.001$). *PGC-1α*, *VEGF* and *NRF2* mRNA expression increased with exercises (*PGC-1α*, $p<0.001$; *VEGF*, $p<0.001$; *NRF2*, $p=0.016$), but was not altered with heating (*PGC-1α*, $p=0.512$; *VEGF*, $p=0.187$; *NRF2*, $p=0.298$). TFAM increased afterexercise with heat application ($p=0.019$) but not with exercise alone ($p=0.422$). There was no difference in *NRF1* or *ESRRα* in response to exercise (*NRF1*, $p=0.069$; *ESRRα* $p=0.65$) or temperature (*NRF1*,$p=0.121$; *ESRRα*, $p=0.443$). Mitophagy related genes did not change with exercise, (*BNIP3*, $p=0.113$; *BNIP3L*, $p=0.76$; *PINK1*, $p=0.113$; *PARK*, $p=0.086$) or in responseto temperature (*BNIP3*, $p=0.098$; *BNIP3L*, $p=0.157$; *PINK1*, $p=.894$; *PARK* $p=0.927$). In conclusion, TFAM is enhanced by local heat application during endurance exercise, whereas other genes related tomitochondrial homeostasis are unaffected.

MECHANISM OF INTERACTION BETWEEN GENE SILENCING PROTEINS USING X-RAY CRYSTALLOGRAPHY

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The accurate replication of DNA and the proper packaging of newly synthesized DNA into nucleosomes are crucial for maintaining genomic stability. Precisely how these nucleosomesare assembled dictates which genes will be active and which will be silent. Two proteins, proliferating cell nuclear antigen (PCNA) and chromatin assembly factor 1 (CAF-1), are essential for this process of replication-coupled nucleosome assembly. PCNA is a homotrimeric sliding clamp required for all DNA-templated metabolic processes. PCNA recruits CAF-1, a histone chaperone required for gene silencing, to sites of nucleosome formation. Disruption of the PCNA-CAF-1 interaction can lead to chromatin rearrangements, inhibition of heterochromatin silencing, and mutator phenotypes, which are common features of many humancancers. However, the mechanism of interaction between these two proteins is unclear. This project aims to determine the interaction between PCNA and CAF-1 at the structural level by performing X-ray crystallography studies using a purified PCNA-CAF-1 complex. These studieswill lead to a better understanding of how these two proteins function together to maintain gene silencing and enhance the current understanding of genetic inheritance and how disruptions in this interaction can lead to disease.

USING BRED-CONSTRUCTED GENE KNOCKOUTS TO DETERMINE FUNCTIONS OF BACTERIOPHAGE GENES IN THE *MYCOBACTERIOPHAGE* FUDGETART

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Bacteriophage are viruses that infect and kill specific bacteria. Therefore, bacteriophage have the potential to be used as a replacement for antibiotics. This use of bacteriophage is called phage therapy. One limitation to the broader use of phage therapy is that many bacteriophage genomes contain genes with unknown functions. Knowledge of these functions is important because we can better understand the process of infection and potentially engineer more effective bacteriophage for bacteriophage therapy. Bacteriophage Recombineering of Electroporated DNA (BRED) is a technique to mutate specific bacteriophage genes to determine their importance for host infection and to help identify their functions. We used the host bacteria *Mycobacterium smegmatis* and *mycobacteriophage* FudgeTart as a case study forBRED. First, we transformed the host bacteria with pJV53, a plasmid that contains the genes for recombinase proteins which allow for replacement of a gene with a mutated version via homologous recombination. Then, we co-transformed the bacteriophage genomic DNA and a DNA oligo containing the desired mutation into the recombineering *M. smegmatis*. We plated the transformed bacteria and screened the resulting plaques to check for mutations in the specific bacteriophage gene. The goal of this project is to establish an efficient process to perform BRED experiments at Doane University, using Doane's extensive collection of bacteriophage. If this experiment is successful, we can continue to use BRED on the bacteriophages in Doane's collection to better understand how bacteriophage work and whether they can be used efficiently for bacteriophage therapy.

HIGH PREVALENCE OF PRE-EXISTING SEROLOGICAL CROSS-REACTIVITY AGAINST SEVERE ACUTE RESPIRATORY SYNDROME CORONAVIRUS-2 (SARS-COV-2) IN SUB-SAHARAN AFRICA

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Over the past year, the Coronavirus Disease 2019 (COVID-19) pandemic, caused by severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), has impacted the entire world, with different locations of the world affected to various degrees. At the time of research, the mortality rates and number of COVID-19 cases in sub-Saharan Africa (SSA) were lower than the United States (U.S.) and much of the rest of the world. This was unexpected considering the high prevalence of infectious diseases and comparatively limited access to healthcare in many rural areas in SSA. One possible reason is that given the higher rate of exposure to infectious agents in SSA, the risk of exposure to other human coronaviruses also increased, which may result in a cross-protective immune response against SARS-CoV-2. Cross-reactive antibodies, which bind to similar antigens, may play a role in protection against infection by different pathogens. It is unknown whether cross-reactive antibodies to SARS-CoV-2, elicited by past infections of other human coronaviruses (HCoVs), are present in pre-pandemic samples. Therefore, the presence of antibodies reactive to SARS-CoV-2 were examined in 289 pre- pandemic plasma samples from SSA and the U.S. adults using immunofluorescence assay (IFA) against the SARS-CoV-2 nucleocapsid and spike proteins. To determine pre-exposure to which human coronaviruses are responsible for SARS-CoV-2 cross-reactive antibodies, pre-pandemic plasma samples that tested positive for cross-reactivity were further examined against six known human coronaviruses by IFA. Our results indicated that cross-reactivity against SARS-CoV-2 has a higher prevalence among SSA than U.S. populations, and majority of the samples recognized the nucleocapsid proteins from HCoV-NL63 and HCoV-229E, indicating pre- exposure to these two HCoVs that cause the common cold as the likely source for eliciting cross- reactive antibodies against SARS-CoV-2. More samples are currently being collected during this pandemic for further analysis to determine how cross-reactive antibodies may affect COVID-19 in SSA.

CHARACTERIZING HIGH PERSISTER PHENOTYPES IN *STAPHYLOCOCCUSEPIDERMIDIS* CLINICAL ISOLATES

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Staphylococcus epidermidis is an opportunistic pathogen of the normal skin flora. Most infections are hospital-acquired through medical devices. More severe cases can result in sepsis and endocarditis. Antibiotic treatment of these infections is often unsuccessful, leading to chronic, relapsing infections with poor patient prognosis. Persister cells (a subpopulation of dormant cells), are a likely explanation for these observations. Recent work in *Staphylococcus aureus* demonstrates persister formation is dependent on energy depletionthrough the tricarboxylic acid (TCA) cycle. Based on these observations, we hypothesized high persister isolates occurred among *S. epidermidis* clinical isolates through an energy dependent mechanism. *S. epidermidis* clinical isolates were frequently found to have a high persister phenotype when challenged with vancomycin. We then set out to identify whether the mechanism for this was from a defective TCA cycle. Disruption of the TCA cycle prevents acetate utilization once glucose is depleted and

accumulates in the extracellular medium. Due tothe defective TCA cycle, the high-persister phenotype is expected to have higher extracellular acetate. Several, but not all of the high persister isolates had increased acetate levels. These results indicate that high-persister formation is often the result of a dysfunctional TCA cycle; however, other mechanisms likely exist.

CRYSTALLIZATION AND STRUCTURAL STUDIES OF PCNA-CAF-1 FUSION COMPLEXES

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During S phase, newly synthesized DNA is wrapped around histone proteins to form nucleosomes, the basic unit of chromatin. This important biochemical process – known as replication-coupled nucleosome assembly – regulates DNA packaging and expression. The interaction between two proteins, proliferating cell nuclear antigen (PCNA) and chromatin assembly factor 1 (CAF-1), is critical to this process. PCNA, a homotrimeric DNA sliding clamp, encircles DNA at the replication fork and recruits CAF-1, which mediates normal genesilencing and continued cell viability through histone deposition and chromatin condensation. Any disruptions to the interaction between PCNA and CAF-1 can impair genetic integrity.

However, the molecular basis of this interaction remains largely unknown. We have identifiedseveral putative binding locations on both PCNA and CAF-1 that are potentially critical for their interaction. We have generated crystals of several complexes of these two proteins and collected preliminary diffraction data. Each of these complexes crystallized under different buffer conditions and protein concentrations, suggesting that there is marked structural differences in the interaction mechanisms between the constructs that can be determined through X-ray crystallography studies. The results of these studies could offer insights into themechanism of interaction between PCNA and CAF-1 during replication-coupled nucleosome assembly, and how they function together to maintain appropriate gene silencing.

ACRYLAMIDE CHARACTERIZATION TO BE USED IN THE ELUTION AND CONCENTRATION OF LAMBDA CONCATEMER DNA MOLECULES

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In order to use physical mapping systems such as Nanocoding or Optical Mapping to discover variations among long DNA molecules, the molecules must be spread out to span a large enough region that there is enough unique information on either side of the aforementioned region so that the area of the genome can be assembled. The fragility of large DNA molecules prevents the molecules from remaining full length when routine molecular biology techniques are used to concentrate DNA. Thus, a 3D printed polyacrylamide (PLA) device was developed and affixed to a glass slide to concentrate lambda DNA concatemers. Acrylamide gels of various concentrations were polymerized in the device to act as a “roadblock” to slow down the progression of DNA through the device. Using a pulsed waveform, DNA molecules were concentrated at the acrylamide roadblock. DNA was stainedwith YOYO-1 dye so that the progression of DNA was monitored while varying the differentacrylamide concentrations. The pore size of the acrylamide

concentrations was determined using a 1 kb ladder to compare the pore size of the gel to the amount of DNA concentrated.

FLUID SHIFTS WITH ACUTE EXPOSURE TO NORMOBARIC AND HYPOBARIC HYPOXIA

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To determine the body fluid shifts that occur with exposure to normobarichypoxia (NH) and hypobaric hypoxia (HH) compared to normobaric normoxia (NN). Eighteen males and females (male=10, female=8, age 35±7 yrs) completed three trials on back- to-back days in a randomized order. NN was conducted at sea level, NH was conducted at sea level but breathing a gas mixture to simulate 4,617 m of elevation, and HH was conducted at 4,617 m of terrestrial elevation. The time and rate of hypoxia exposure was consistent between NN and HH (0 m to 4,617 m in 90 minutes). Finger-stick blood samples were taken after the 90 minute intervention and analyzed for hemoglobin and hematocrit to calculate plasma volume shifts and urine was collected to measure urine specific gravity. After10 minutes of supine rest, body water was analyzed via BIA (In-Body s10). Plasma volume change was not altered by NH relative to NN (-3.77±8.36%, $p = 0.073$) but lower in HH relative to NN (- 16.610±7.84%, $p<0.001$). Urine specific gravity was similar between all trials ($p=0.120$, main effect). Total body water was not different between NN (43.8±7.6 L) andNH (43.7±7.7 L, $p=0.492$) but was lower in HH (43.0±7.6 L) than NN ($p<0.001$) and NH ($p<0.001$). Extracellular fluid was not different between NN (16.35±2.85 L) and NH (16.32±2.84 L, $p=0.696$) but was lower in HH (16.08±2.78 L) than NN ($p<0.001$) and NH ($p=0.006$). Intracellular Fluid was not different between NN (27.41±4.81 L) and NH (27.33±4.89 L, $p=0.420$) but was lower in HH (26.97±4.80 L) than NN ($p<0.001$) and NH ($p=0.016$). In conclusion, body fluid shifts are stimulated by an alteration of barometric pressure and not by hypoxia. Caution should be made when applying data from studies conducted in NH to HH.

CHEMICAL ATTRACTION OF TICKS (PARASITIFORMIS: IXODIDAE) TO DECOMPOSITION VOLATILE ORGANIC CHEMICALS

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For arthropods that require blood to complete their life cycle, finding an acceptable bloodhost is an integral component. One method to increase host-finding may be found in certain tick species: to preferentially move to carrion and/or be mechanically transported bynecrophagous insects to carrion, which increases their chances of finding a host. Although ticks use a combination of senses to locate hosts, they depend the most on chemical cues. Knowing this, we investigated two major research questions: 1) are ticks attracted to animal decomposition, and 2) if so, which volatile organic compounds are they attracted to? The research questions were divided into individual experiment trials using the adult tick species*Amblyomma americanum* (Lone star tick) and *Dermacentor variabilis* (American dog tick). Both trials were conducted with a dual-choice olfactometer. Trial 1 was conducted using a dead fetal pig. Tick attractiveness to the remains was tested every 24 hours for 168 hours (7 days). Trial 2 was conducted using individual

volatile organic compounds. These included: dimethyl disulfide, dimethyl trisulfide, trimethylamine, indole, and phenol. Compounds were determined based on previous decompositional VOC research. Carbon dioxide was used as a control. Knowing tick attractiveness to animal decomposition can lead to better understanding of their host-finding behaviors and can lead to better tick population control measures.

DETERMINING THE MECHANISM OF ACTION OF AN ANTI-SCHISTOSOMAL COMPOUND

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Schistosomiasis is a condition caused by a parasitic worm infection that predominantly affects third world countries. There has been a novel drug developed that has demonstrated efficacy against worm infection. Preliminary data from our lab suggests that granulocyte surface markers are upregulated alongside these cells' ability to produce reactive species in murine splenocytes post treatment. Through a resazurin reduction assay and a Luciferin ATP assay, we examined the effects of this novel drug on granulocytes' ability to produce reactive oxygen species using ATP and NADH.

INVESTIGATING THE ROLE OF NOSTRILL EXPRESSION IN A TMEV-IDD MOUSE MODEL OF MULTIPLE SCLEROSIS

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Viral infections in the central nervous system are associated with increased neurodegeneration and widespread neuroinflammation leading to direct or immune-driven cellular apoptosis and necrosis. In response to infection, microglia are known to elicit neurotoxic inflammation or supportive neurogenesis depending on the presence of specific molecular activators. Long non-coding RNAs have been found to affect a diverse array of microglial responses to viral infection. Our lab has exhibited a regulatory role of the long non-coding RNA Nostrill in neuroinflammation following viral infection in vitro. Nostrill expression was markedly increased following virus infection, but the specific cellular subtype or localization of up-regulation is currently unknown. Viral mouse models are utilized to test hypotheses regarding the mechanism of action of such responses. Our lab utilized an FVB/nJ mouse model that is susceptible to sustained Theiler's Murine Encephalomyelitis Virus (TMEV) infection and serves as a model for Multiple Sclerosis. Mice were intracranially injected with TMEV or control HBSS and sacrificed 36 dayspost-infection for evaluation of RNA expression and immunohistochemical analyses. Enhanced Nostrill expression is observed in TMEV cortical tissue utilizing RT-PCR. Preliminary immunohistochemistry demonstrates enhanced proliferation of microglia in TMEV infected cortices. Fluorescent in situ hybridization experiments were performed tolocalize Nostrill expression to specific cellular subtypes in the cortex. Mouse brains were sliced in 40-micron sections and placed in a 1-in-3 series. Slides were then blocked against any non-specific binding with 1% BSA in 1X PBS and 0.1% Tween 20 for 30 minutes at room temperature. Primary antibodies were used to detect microglia (anti-Iba1), astrocytes (anti-GFAP), and neurons (anti-NeuN). Fluorescent secondary antibody was then applied for1 hour at room temperature and

expression was visualized following Nostrill probe development. Understanding the cellular mechanisms that potentiate microglial activity can elucidate potential sequences of neuroprotective pathways.

DENDRITIC CELLS DISPLAY SEX-SPECIFIC DIFFERENCES IN ABILITY TO MOUNT IMMUNE RESPONSE TO PEANUT

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The mechanism of how peanut (PN) initiates immune responses to elicit PN allergy remains limited. PN is commonly found in household dust and we have shown that PN exposure via inhalation sensitizes mice. Little is known about how dendritic cells (DCs), a type of immune cell critical to initiate adaptive immune responses, function in response to airway exposure to PN. Even more unclear is how sex differences impact the DCs ability to respond to PN. This study compared male and female mice exposed to PN in 3-day mouse models to elucidate how sex differences impacted the response of DCs to PN. To study, lung draining lymph nodes (dLN) were collected from BALB/c male and female mice after exposure to PN flour byinhalation three times during a 3-day period (days 0,1,2). Single cell suspensions were stainedwith antibodies to identify DC-specific responses to PN by flow cytometry. We started by examining DCs more broadly using the classic CD11c DC stain before zeroing in on whether differences existed in different CD11c+ subsets, namely CD103+ and CD103- DCs, two DCs that have been implicated in capturing PN to mount PN-specific responses. Interestingly, both CD11c+ and CD103+ DCs were reduced in male mice exposed to PN when compared to theirfemale PN- exposed counterparts. These results strongly suggest that testosterone modulates immune responses against PN exposure. Future studies will build on these fascinating data to allow us to better understand sex differences associated with PN allergy.

EVOLUTION OF A SUBSET OF NUCLEAR RRNA INTRONS IN THE LICHENPHYSCIA

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Introns are found in all sequenced eukaryotic genomes, yet their origins are unclear. This is due to their antiquity and the lack of selective pressure, which results in high sequence divergence. This has made finding intermediate forms difficult. However, some of these issues appear to be mitigated in nuclear ribosomal RNA (nrRNA) in lichen-forming and allied fungi. Introns are particularly abundant in the genus Physcia. In this project, we focus on introns at two sites (1092, 1094) within the large subunit (LSU) rRNA gene. Previous work showed that these introns never co-occur in the same repeat, but they are both found in the genomes of at least 36 different isolates. Based on sequence similarity we hypothesized that the two introns share a common origin. In this study, we sought to expand the sample size by sequencing the intron from additional geographic isolates. In the process, we identified intron presence/absence heterogeneity among rRNA repeats as well as a novel intron position (1090). We hypothesize that all introns in the 1090-1094 region share a common ancestor with diversification being partially driven by alternative splicing.

USING BACTERIOPHAGE RECOMBINEERING OF ELECTROPORATED DNA (BRED) TECHNIQUE TO MARK ESSENTIAL AND NONESSENTIAL GENES FOUND IN A BACTERIOPHAGE'S GENOME

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A bacteriophage is a virus that has the ability to infect specific bacteria. With the epidemic of antibiotic-resistant bacteria, understanding how bacteriophages infect bacteria andwhat genes are specific to that process is crucial for the future medical treatment for bacterial infections. Using the Bacteriophage Recombineering of Electroporated DNA (BRED) technique can help identify key genes found in bacteriophages that can be useful for phage therapy. I have selected a sequenced bacteriophage named Jabith that infects the host bacteria *Mycobacterium smegmatis*. The phage Jabith is lysogenic, meaning it incorporates its DNA into the host bacteria's genome for replication. Changing infection behavior by engineering Jabith's genome using BRED by deleting a gene could make the phage infect in a lytic life cycle. I hypothesize that if we deleted an essential gene then the bacteria infected would not produce plaques. The phage DNA was isolated and used for transformation into a recombineering *M. smegmatis* to control for transformation efficiency. Currently, we are identifying important genes for lysogenic growth in Jabith's genome. We will use this gene sequence to guide the construction of oligos. The next steps after constructing an oligo is to use BRED to knock out a gene. This will illustrate what genes are vital for its lysogenic growth to understand what genes are specific tofor infecting and killing *M. smegmatis*. By finding what genes cause a change from lysogenicto lytic lifestyle in Jabith using BRED, can help with the availability of phage therapy treatment.

RE-EXAMINATION OF FILAMENTATION REQUIREMENTS OF C. ALBICANS: EARLY FILAMENTATION PROFILES NEAR POST-DIAUXICPHASE

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Candida albicans is a commensal fungus normally found within the human microbiome. Despite its normally neutral presence, *C. albicans* is an opportunistic pathogen when the host's immune system and its neighboring microbiota are unable to keep it in check. Systemic infections by *C. albicans* in immunocompromised individuals are potentially fatal due to difficulty in clearance of the fungus with current medications. This pathogenicity in *C. albicans*is heavily reliant on its ability to filament and transition between yeast and hyphal states. Filamentation is known to require the absence of quorum sensing factors like farnesol and the presence of inducing conditions. However, a third factor may be required for filamentation. Our data suggests that there is a third trigger for filamentation, that cells must be in post-diauxic phaseprior to induction in order to filament. Cells were assessed for filamentation at 3, 6, and 9 hourtime points starting with either log phase or post-diauxic phase cells in inducing conditions. Cellsgrown in inducing conditions from log phase cells failed to grow as true hyphae in any inducingcondition tested, although pseudohyphae were observed in some inducing conditions. To furthercharacterize the post-diauxic phase in light of these findings, genetic profiling of the post- diauxic phase is underway. Our study points to a need to change the fundamental requirementsfor filamentation in *C. albicans* to include the post diauxic phase.

CONSTRAINT BASE MODELLING OF MUS MUSCULUS LUNGS

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Constraint based modelling is a mathematical method used to elucidate complex systemsby placing limitations on parameters. An objective function, that is the primary goal of said system, is set to be maximized. For metabolic modelling, biomass generation is a common objective function, though it does not make sense for certain organ systems, the brain for example. RNA-Seq, short for RNA sequencing, is a method of genome analysis that can be used to obtain gene expression data. Gene expression for lung tissue of Mus musculus, the housemouse, was obtained from open-source database NCBI. Control data from healthy mice aged between 6-12 weeks was analyzed and then used to develop a mathematical model of the mouselung. The expression of the relevant genes was linked to the molecular products and then modelled using linear programming.

HOMODIMERIZATION OF SATB1 AND HETERODIMERIZATION OF SATB1 AND SATB2 PRIOR TO NUCLEAR IMPORT

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Satb1 and Satb2 are closely related proteins that regulate gene expression through chromatin reorganization. The relative concentrations of Satb1 and Satb2 have been implicated in the regulation of embryonic stem cell differentiation through regulating the expression of Nanog. Satb1 is thought to form homodimers or homo-oligomers through interactions with its N-terminal domain, although it is not yet known if this homodimerization is DNA dependent. The high degree of conservation between Satb1 and Satb2 has led to speculation that they can form heterodimers. We hypothesize that Satb1 homodimerizes and Satb1 and Satb2 heterodimerize with each other in the cytoplasm, prior to their entry into the nucleus. However, the degree of similarity between Satb1 and Satb2 make it challenging to employ traditional biochemical approaches such as co-immunoprecipitation. Here, we proposea set of experiments using fluorescence microscopy to determine if there is interaction between Satb1 and Satb2, and whether this interaction is dependent on the presence of DNA. Pairs of chimeric proteins will be co-expressed in HeLa cells. Each protein will feature a different fluorescent protein, and one of these in each pair will have its Nuclear Localization Sequence (NLS) mutated to a loss of function. This NLS-deficient mutant will only be able tobe imported into the nucleus through dimerization with its import-competent partner prior to its import.

EFFECTS OF FOOD DEPRIVATION ON ANXIETY-LIKE BEHAVIOR IN MICE

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Emotional processers in the brain, such as the hypothalamus and amygdala, are ableto influence changes in behavior when under stressful situations. Changing an animal's nutritional state can induce stress and thus alter their sex steroid levels. In addition to their role in sexual differentiation, sex steroids may also act as anxiolytics to reduce anxiety. Therefore, we hypothesized that mice that were food-deprived for 24 hours would exhibit higher levels of anxiety-like behavior compared to animals that had continuous access to food. If food deprivation triggers the emotional centers of the brain, then mice that are food deprived would spend less time

in the open arm of an Elevated Plus Maze (EPM). Wildtype (wt) female, wt male, and testosterone feminization mutant (tfm) mice were divided into twogroups: 1) mice that were food-deprived for 24 hours or 2) mice that were given continuousaccess to food. Subjects were then tested on an EPM for 10 minutes to measure anxiety-like behavior. We found that there was no significant effect of genotype or diet on the average time spent in the open arm, not supporting our hypothesis of androgen receptor differences. This may have beendue to the inadequate amount of time the mice were food deprived. In future research, we hope to have another group that is food deprived for a longer period of time for effects to set in.

DECREASED TRICARBOXYLIC ACID (TCA) CYCLE IN *STAPHYLOCOCCUSAUREUS* INCREASES SURVIVAL TO INNATE IMMUNITY

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Staphylococcus aureus is a gram-positive bacterium responsible for 3 million cases of infection in the United States every year. A decrease in ATP is connected to an increase in persister cell formation, which is associated with chronic relapsing infections. The underlying mechanism of persister formation is linked to an interrupted tricarboxylic acid (TCA) cycle. While persisters exhibit tolerance to antibiotics, their role in pathogenesis remains unclear. Initial studies have demonstrated that a *fumC* knockout (TCA cycle gene) survives challenge from innate immune components - antimicrobial peptides – better than wild type *S. aureus.* Additionally, following infection in *Drosophila melanogaster*, the *fumC* knockout exhibited increased survival. These data led us to hypothesize the *fumC* knockout is better suited for survival to other components of innate immunity, leading to increased survival within a host. Furthermore, preliminary results have also demonstrated increased survival of the *fumC* knockout within a macrophage. Next, survival to phagocytic antimicrobial factors (reactive oxygen species (ROS), reactive nitrogen species (RNS), and decreased pH) was examined. The*fumC* knockout had increased growth in the presence of all three stressors, however no differencewas observed in the presence of any single factor alone. Additionally, a biofilm-associated catheter infection was performed within a mouse. Following a 9-day infection, female mice infected with wild type HG003 were trending towards more frequently clearing the infection compared to female mice infected with the *fumC* knockout strain. These findings suggest that persisters not only present a challenge during antimicrobial therapy but also for the innate immune system.

SYNTHESIS, REACTION KINETICS AND ANTIMICROBIAL EVALUATION OF 1,2,3-TRIAZOLE-CONTAINING PHENANTHRIDINES

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1,3,4-Trisubstituted-1,2,3-triazolium salts have been shown to possess antibacterial and antifungal properties, though these properties vary depending on the substituents utilized. This project's aim was to compare the antimicrobial properties of ring-fused 1,2,3-triazolium salt analogs representing the 1,2,3-triazole-containing phenanthridine ring system to their analogous non-fused triazolium salts. 1,5-Disubstituted-1,2,3-triazoles were prepared from a base- catalyzed click reaction between terminal alkyne and aryl azide reactants. The ring- fused 1,2,3- triazole-containing phenanthridine analogs were prepared by an intramolecular Pd-catalyzed cross-coupling "fusion" reaction of 2-bromoaryl-substituted triazole precursors. Triazolium salts were

prepared by N3 benzylation of each analog, which were screened for antimicrobial properties using a microdilution minimum inhibitory concentration assay against Gram-positive bacteria, Gram-negative bacteria and yeast. Analogs possessing 4-tert-butylbenzyl substituents at the N3 position had the strongest antimicrobial potency, and fused-ring chloro-substituted analogs were significantly more potent than their non-fused counterparts. The varying substituents on the N1 and C5 phenyl units among alkyl and chloro groups also enabled the reaction kinetics of both the click and fusion reactions to be examined. Details regarding the synthesis, characterization, and antimicrobial assays of these compounds will be presented. This publication was made possible by grants from the NationalInstitute for General Medical Science(NIGMS) (5P20GM103427), a component of the National Institutes of Health (NIH), and its contents are the sole responsibility of the authors and do not necessarily represent the official views of NIGMS or NIH.

ANALYSIS OF MITOCONDRIAL EFFICIENTY BETWEEN NORTH AMERICAN YAK MITOTYPES

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Domestic yak (*Bos grunniens*) are bovids native to the Asian Qinghai-Tibetan Plateau. Yak were imported to North America (NA) in the early 1900s. The beginning of this study aimedto use mitochondrial (mt) DNA sequence data to better understand the mtDNA origin ofNA yak.Ten unique haplotypes were identified among the complete mtDNA sequences of 14 NA yak, which a haplotype network separated into two clusters. A maximum likelihood tree including yak and publicly available sequences of similar species placed six haplotypes of NAyak into a clade with *B. indicus* cattle; the other four NA yak haplotypes grouped with domestic yak (*B. grunniens)*. These data demonstrate two mitochondrial origins of NA yak with substantial genetic variation in protein coding genes. Mitochondria are essential for fitness andmetabolism and the finding of 93 nonsynonymous single nucleotide polymorphisms (SNPs) between the two major clades of NA yak suggested the mitotypes in NA yak may functionally differ. The objective of the most current study was to use skeletal muscle satellite cells from NA yak representing both mitotypes to investigate potential function differences. Primary cell culturewas used to grow satellite cell lines of eight domestic yak, 5 with cattle-type mt and 3 with yak- type mt. The autosomal genome of each was primarily (> 95%) yak. Once isolated, the rate of ATP production from glycolysis and mitochondrial respiration was quantified with the ATP RateAssay on Seahorse XF Extracellular Flux Analyzer. Real time measurements of mitochondrial oxygen consumption rates (OCR) and glycolytic extra-cellular acidification rates (ECAR) were taken by the assay and quantified as mitochondrial ATP rate and glycolysis ATP rate. Analysis based on mitotype showed there was no significant difference intotal ATP production between yak and cattle type mitochondria. However, glycolytic rates for cell lines with yak mitochondria were lower (P<0.05) than those with cattle type mitochondria. This finding suggests mitochondria in satellite cells from yak with the yak-type mt are responsible for a larger portion of energy production. These data provide evidence that genetic variation in mitochondrial genes of NA yak contribute to phenotypic changes in mitochondrial respiration.

EFFECTS OF CURCUMIN ON TRIPLE NEGATIVE BREAST CANCER

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Triple negative breast cancer (TNBC) is a type of breast cancer that accounts for 10%-25% of all breast cancer cases. TNBC lacks estrogen and progesterone hormone receptors andthe overexpression of the human epidermal growth factor receptor 2 (Her-2) receptors. Due tothe lack of the two hormonal receptors and overexpression of Her-2, the current hormonal or Her-2 targeted treatments are ineffective towards TNBC. The current standard treatments for TNBC are chemotherapy, radiation, and surgery; however, TNBC is resistant to most current treatments due to the heterogenous characteristic of the tumor. Therefore, the development of more effective therapies is essential. The chemical extract of turmeric, curcumin, has demonstrated anti-inflammatory activity in several studies. Curcumin has shown therapeutic effects against some inflammatory conditions, and therefore is currently being used as a topical anti-inflammatory to combat chemotherapy-induced inflammation and resistance through the activation of survival pathways. The purpose of this research is to explore whether and how curcumin affects the survival of TNBC cells. Specifically, we examined the effects curcumin on the NF-κB pathway in MDA-MB-231 cells, an established TNBC cell line. The NF-κB pathway is a known pro-survival pathway which is constitutively activated inMDA-MB-231 cells. MDA-MB-231 cells were treated with varying amounts of curcumin ranging from 0μM to 80μMfor 24 hours. The effect of curcumin on the cellular activity was assessed using an MTTassay. The result shows that as the concentration of curcumin increases, the percentage proliferation decreases. 24 hours after 40μM treatment, the cellular proliferation decreasedby 95.8%. GraphPad prism was used to analyze the MTT assay result and to calculate the IC-50 of curcumin on the MDA-MB-231 cell line. The IC-50 of curcumin was calculated to be 4.5μM.In addition, the effect of curcumin on the protein levels of NF-κB pathway members is being assessed using Western blots.

CHARACTERIZATION OF VIRUS INFECTION OF PSEUDOMONAS FLUORESCENS USING RNA SEQUENCING

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The *Pseudomonas* genus is a large and diverse group of bacteria that occupy nearly every environmental niche. Some examples of the genus, such as *Pseudomonas aeruginosa*, are commonly found in hospitals and cause serious human diseases. Other examples, such as *Pseudomonas fluorescens*, cause mild to no symptoms in humans, and are commonly found in various soils and water samples. Despite their relatively widespread nature, all members of the *Pseudomonas* genus are susceptible to viruses known as bacteriophages. Somewhatsurprisingly, despite extensive research, both the bacteria and their bacteriophages still have many proteins and genes that are termed “hypothetical”, and as a result many of their functions are also unknown. Using novel Podoviruses that have been isolated in our laboratory and the *Pseudomonas fluorescens* host, we seek to elucidate the mechanisms and functions of these “hypothetical” genes and their gene products by studying gene expression changes during viral infection. These gene expression changes, determined using RNA sequencing, will elucidate thephage genes previously unrecognized during infection of *P. fluorescens* over time and as they induce a stress response. These genes are initially found through next generation sequencing (NGS) and functionally annotated for characterization of phylogenetic homology. Validation of this work will be performed using co-occurrence network analysis to identify frameshiftmutations or gene hubs of various *Pseudomonas* bacteriophages that correlate with virus pathogenicity or phenotype. By mapping the course of gene expression of *P. fluorescens* and aninfecting bacteriophage, we will

learn more about the genes and gene products of both the hostand the virus. This should provide greater insight into bacteria in the *Pseudomonas* genus, including those that cause human disease.

GENOME-WIDE ASSOCIATION STUDY OF TINNITUS IN THE UK BIOBANK POPULATION

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Tinnitus, the phantom perception of noise originating from the inner ear, is experiencedby 15% of the world's population, with many patients reporting major deficits to cognition and mood. However, both objective diagnostic tools and targeted therapeutic strategies have yet to be established. To better understand the underlying genes that may preclude tinnitus, we performed a genome-wide association study of the UK Biobank's 49,960 whole exome sequencing participants to identify any loci strongly associated with tinnitus. We identified 17 single nucleotide polymorphisms spanning 13 genes in two sex-separated, cohorts reporting chronic, bothersome tinnitus. We also found a significant missense mutation in *WDPCP* (p=3.959e-10) in the female cohort, a mutation which has been previously implicated in typicalneuronal functioning through axonal migration and structural reinforcement, as well as in Bardet Biedl syndrome-15, a ciliopathy. Additionally, *in situ* hybridization in the P56 mouse brain demonstrated that the majority of these genes are expressed within the dorsal cochlear nucleus, the region of the brain theorized to initially induce tinnitus. The results of this study indicate that predisposition to tinnitus spans across multiple genomic loci and may be establishedby structurally weakened neuronal circuitry within the dorsal cochlear nucleus.

ANALYSIS OF BACTERIAL GROWTH IN THE PRESENCE OF *glmS* RIBOSWITCH LIGAND ANALOGS

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Many members of public health systems are becoming increasingly concerned about antibiotic resistance. Antibiotics that have been developed in the past are becoming less effective as bacteria adapt to the stressors that these drugs attempt to induce within them. Bacterial genomes acquire new genes in order to prevent the debilitating effects of the antibiotics. Recently, researchers have begun investigating the potential of riboswitches as antibacterial drug targets. Riboswitches are sections of non-coding mRNA that effect the expression of downstream genes in response to ligand binding. The *glmS* riboswitch controls the expressionof fructose-6-phosphate amidotransferase which catalyzes the production of glucosamine-6- phosphate (GlcN6P), a precursor in bacterial cell wall synthesis. Importantly, the *glmS* riboswitch is categorized as a catalytic ribozyme due to the fact that it demonstrates self- cleavage upon binding to GlcN6P. This negative feedback degrades the mRNA, inhibiting *glmS* gene expression and preventing synthesis of the cell wall. The *glmS* riboswitch is highlyprevalent in bacteria, determined to be in more than 400 strains ofgram-positive bacteria and 5 strains of gram-negative bacteria. Some of the gram-positive bacteria that contain the g*lmS* riboswitch include *Staphylococcus aureus*, a super bug, *Bacillus anthracis*, a bioterror threat, and *Clostridium tetani*, the causative agent of tetanus. Due to its prevalence and its ability to control cell viability, the *glmS* riboswitch is a potential target for new antibiotics. This projectaims to identify an analog with similar affinity as GlcN6P for the *glmS* riboswitch to catalyze self-cleavage of the riboswitch to decrease cell viability. Growth

assays were performed to monitor the growth of *Bacillus subtilis* and *Staphylococcus aureus* in the presence and absence of potential GlcN6P analogs with the goal of decreasing or eliminating bacterial growth. Current studies suggest that L-serine can decrease bacterial growth at concentrations of 8 mM. Future studies will verify that the analogs are decreasing growth via interaction withthe *glmS* riboswitch and will investigate the effects of these analogs on mutant strains of *B. subtilis* and *S. aureus*.

NADH PHASOR FLIM IMAGING IN THE EARLY DETECTION OF UVA-INDUCED SKIN CANCER IN SKH1 MICE

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Signature alterations to metabolism distinguish cancerous tissue from heathy tissue long before gross morphological changes have become evident. These changes include shifts in the binding characteristics and distributions of metabolic cofactors like nicotinamide adenine dinucleotide (NADH) and flavoproteins. Our ongoing research examines the application of Phasor-FLIM for the early detection of skin cancer via non-invasive optical biopsy. We used chronic UVA exposure to induce skin cancer in mice over the course of a 36 week experiment. Regular imaging sessions allowed for the collection of longitudinal data. FLIM data from these images was transformed and plotted to generate phasor-FLIM profiles of mice at various points incancer progression. Previous animal trials have been successful in indicating a lower bound- to-free ratio in UV exposed skin, representative of the glycolytic preference associated with cancer. Improving on previous work, this study is separately measuring fluorescence from collagen. By accounting for this non-NADH signal, our phasors better reflect the changes in metabolism due to cancer. This publication was made possible by grants from the National Institute for General Medical Science (NIGMS) (5P20GM103427), a component of the National Institutes of Health (NIH), and its contents are the sole responsibility of the authors and do not necessarily represent the official views of NIGMS or NIH.

PROTEIN RELATED TO ALZHEIMER'S DISEASE PLAYS A ROLE IN ZIKA VIRUS INFECTION

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Zika virus (ZIKV) is a neurotropic flavivirus, infection by which can lead to microcephalyin babies and Guillain-Barre syndrome in adults. Flaviviruses are single-stranded RNA viruses, including West Nile virus and Dengue virus. Amyloid Precursor Protein (APP) isa membrane protein associated with the development of Alzheimer's disease through its involvement in the generation of amyloid plaques. APP is predominantly expressed in the brain and has restricted expression in other organs, so the roles it may play outside the brain are not fully understood. Although there is plenty of research on ZIKV, there is no clinically approved treatment or vaccine for ZIKV-mediated diseases. There is limited knowledge regarding what host factors ZIKV interacts with to modulate the progression of the disease. The spleen is the organ of the body dedicated to filtering the blood, removing old and damaged blood cells. As part of the lymphatic system, it plays a crucial role in mounting an immune response to bacterialor viral infections. In the spleen, the level of APP expression is usually low. We have demonstrated that

ZIKV infection in mice causes the upregulation of APP protein in the spleen.Additionally, we observed that cells expressing APP have more protection against ZIKV and provide protection for other surrounding cells. The overexpression of APP in the spleen may playan important role for the host to counteract ZIKV-mediated pathogenesis. We are currently working to ascertain the exact role of APP, its induction mechanism, and how this expression influences ZIKV replication using a genetic approach. This work may provide novel informationabout host-viral interaction and a potential target for anti-ZIKV treatment. It also could provideinformation about ZIKV and the development of Alzheimer's, with both being linked to APP expression.

SEX HORMONES PLAY A CRITICAL ROLE IN MODULATING THE IMMUNE RESPONSE TO PEANUT

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The prevalence of peanut (PN) allergy is increasing rapidly. While PN allergy is a major medical and economic problem, our knowledge of the immunological mechanisms involved inthe development of the disease remains limited. Sexual dimorphisms have been observed in allergic asthma and in autoimmune diseases such as systemic lupus erythematosus (SLE). However, how sex hormones regulate the immune pathways that lead to the development of PN allergy is unknown. This study aims to better understand how sex hormones impact the development of allergic responses to PN. Male and female wild type C57Bl/6 mice were sensitized to PN in our established four-week PN inhalation mouse model. Wild type (WT) males had significantly less IgE levels than WT females. When WT male and female C57Bl/6 mice were gonadectomized and implanted with capsules containing opposite sex hormone (e.g. β-estradiol in males and dihydrotestosterone in females), data showed females treated with testosterone displayed reduced allergic reactions to PN. Taken together, this data stronglysuggests that sexual differences exist in the development of PN allergy and furthermore, supports that testosterone plays a role in modulating allergic immune responses to PN.

ELASTOMER-BASED MICROFLUIDIC MIMETICS FOR THE PHYSICS OF CANCER

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The term elastomer is a portmanteau for elastic polymer. We use an elastomer, polydimethyl siloxane (PDMS), for fabricating and replicating structures withmicroscopic and nanoscopic features. Microscopic structures within the body such as the pulmonary microcirculation and the microenvironment of cancer cells can be mimicked *in vitro* using microfluidics. Such mimicry is an important tool for the physics of cancer, a new researchfrontier that seeks to unravel the role of mechanical properties, forces, and interactions on cancermetastasis with the aim of enabling new therapeutic strategies against metastasis. Here, we useelastomer-based soft lithography to make microfluidic devices for the physics of cancer. Mix PDMS with a curing agent, pour it onto silicon molds made by photolithography, oven-bake it into a solid structure, and bond glass coverslips under vacuum and air plasma. The device is called microfluidic microcirculation mimetic (MMM). The passageof cells driven through MMM should be correlated

with the mechanical properties of the cells. MMMs with 5 and 7 μm as the smallest constriction widths (maximum width 15μm) are made with a constant height of 15 μm. The inlet and outlet of the devices are connected to a syringe pump and the setup is placed on an inverted microscope for experiments.We have successfully made hundreds of these devices for experiments. The MMM is a physiologically relevant lab-on-chip device for mimicking various microscopic events going on in the body including the circulatory phase of cancer metastasis. This mimicry may enable the development of better diagnostic and therapeutic strategies against cancer metastasis.

ANTI-CANCEROUS EFFECTS OF MONONAPHTHYL TRUXILLATE ONPROSTATE CANCER CELLS

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Subsequent to heart disease, cancer is the second leading cause of death in the United States. More than one-fifth of the deaths in the United States are due to cancer. That is nearly 600,000 deaths per year. Fatty acid binding proteins (FABPs) have recently been investigatedas a possible drug target to treat cancer because of their role in the malignant progression of cancer cells. It has been shown that some cancer cells, namely prostate cancer cells, exhibit increased levels of FABPs. A recent study has shown that SBFl26 (α-truxillic acid 1-naphthylmonoester) targets FABPs and inhibits the FABP5-PPARγ-VEGF signaling pathway. We hypothesized that a similar compound to SBFl26, mononaphthyl truxillate, would have a cytotoxic and antimetastatic effect on prostate cancer cells. For this study, we used PC3 (metastatic prostate cancer) cells to investigate the anticancer potential of mononaphthyl truxillate. We also performed migration assays to analyze the migratory response of PC3 cellsafter treatment with this compound. Our results show cytotoxic effects of mononaphthyl truxillate at microM concentrations when cells were treated for 48h. Migration assay using scratch wound healing technique showed lack of covering of scratch using microM concentrations of mononaphthyl truxillate when compared to control. This assay is an indirectmeasurement of metastasis of cells. Thus far, we can conclude that at microM concentrations mononaphthyl truxillate could be a viable prostate cancer treatment option by causing toxicityand preventing metastasis.

SATB1 FORMS HOMODIMERS INDEPENDENT OF DNA

Kade Wehrs and Brett Schofield, Department of Biology, Doane University, Crete, NE 68333

Chromatin reorganization is one of the many factors that influence gene regulation, and Satb1 is one of the few proteins that has been implicated in this process. This conformational change is used to switch cell behavior in a number of important ways, including being a factor in determining whether embryonic stem cells differentiate. Satb1's mode of activity is uncertain, but it contains three DNA-binding domains that bind to AT-rich sequences. Many DNA-binding proteins dimerize in order to recognize longer stretches of DNA, but there is conflicting evidence whether this is true for Satb1. Here we show that a fluorescently tagged Satb1 is able to drag a nuclear-import deficient mutant of Satb1 into the nucleus. This demonstrates that Satb1 forms homodimers in a DNA-independent manner, andthat they are stable enough to persist through nuclear import. Truncations of Satb1 are currently being tested to identify which region of Satb1

is responsible for homodimerization.

INVESTIGATION OF MXB AS A RESTRICTION FACTOR OFCYPRINID HERPESVIRUS-3

Halle Weise, Dane M. Bowder, PhD, Department of Biology, Doane University, Crete, NE 68333

Cyprinid Herpesvirus-3 (CyHV-3) is a highly contagious agent that causes fatal disease in koi fish and common carp. The rapid spread of this virus, beginning in the 1990s, has caused severe financial losses for both koi and carp industries globally. Human MxB hasrecently been shown to be a pan-herpesvirus restriction factor, of human and mouse herpesviruses. To date, MxB has not been studied in the context of CyHV-3. In this study, we aimed to determine if MxB has the capability to restrict viral replication in fish cells through overexpression and CyHV-3 challenge experiments.

ANALYSIS OF JEG-3 CELL INFLAMMATION AND ENDOPLASMIC RETICULUM STRESS RESPONSE AFTER HOG DUST EXPOSURE

Jenna Whitmore, Department of Biology, Nebraska Wesleyan University, Lincoln, NE 68504; Philma Glora Muthuraj, Sathish Kumar Natarajan, Department of Nutrition & Health Sciences, University of Nebraska-Lincoln, Lincoln, NE 68583

Ambient air pollute on has proven to be a health hazard specifically during pregnancy. Further, particulate matter (PM) has been shown to cross the placenta and reach the fetal side, which results in inhibition of trophoblast growth, inflammation, and endoplasmic reticulum stress. All of which can lead to many hypertensive diseases, including eclampsia/pre- eclampsia. These hypertensive diseases remain the leading cause of maternal death in pregnancy. The overarching study aims to identify the protective role of omega-3 fatty acid- derived SPM against inflammation. In order to understand the protective role, expression of inflammatory cytokine on hog dust exposure in placental cells was done. Relative mRNA quantification of pro-inflammatory cytokine IL-1β was done in JEG-3 cells treated with varying concentrations of hog dust, between one and five percent, at both 8 and 48 hours. To test the activation of endoplasmic reticulum stress, a XBP1 gene splicing assay was done withJEG-3 cells treated with the same varying concentrations of hog dust. In IL-1β expression, nosignificant difference between the control and treated cells was observed. However, the XBP1gene splicing assay did show signs of endoplasmic reticulum stress.

REPRODUCTIVE ECOLOGY OF STUCKENIA PECTINATA

Adam Wilson, Monroe Pruett, Neha Lamsal, Karis Choy, Mackenzie Taylor, Department of Biology, Creighton University, Omaha, NE 68178

Water-pollination, or hydrophily, occurs when a flower releases pollen that then floats along the water's surface to another flower or back to the flower that released the pollen. Water-pollination is a rare method of pollen transfer demonstrated in a handful of flowering plant families. Hydrophilous plants provide food and habitat, but also attenuate waves and are primary producers in aquatic environments. Increased knowledge of water-pollination enables people to better maintain ecosystem health and better understand the traits that facilitate hydrophilous

plants' success. Despite the key roles that hydrophilous plants fulfill, information about hydrophilous traits is lacking, especially regarding the development of pollen after it arrives at a flower. Such information is key to understanding the reproductive consequences of a shift from a terrestrial environment to an aquatic environment. Post-pollination development is shaped by selection on pollen and carpel traits, including those that determine the ability of flowers to self-pollinate and pollinate other flowers. Data regarding post-pollination events willenable cross-comparisons between hydrophilous plants and other plants with different pollination systems to understand the key traits that allow water-pollination to be a viable pollination transfer mechanism. To obtain information about water-pollination, Stuckenia pectinata will be examined to characterize the morphology of the carpel, determine fruit set, anddetermine self-pollination efficiency versus cross-pollination efficiency. S. pectinata is a plant with thin, thread-like leaves that grows most commonly in the shallow depths of lakes and ponds. The results will be compared to other hydrophilous plants, such as Ruppia maritima, to understand key adaptations of hydrophilous plants in relation to other flowering plants.

EFFECTS OF OXYGEN LEVELS AND CULTURE CONDITIONS ON THE CELLULAR METABOLISM ON SQUAMOUS CELL CARCINOMA (SCC) CELLS

Daniel H. Wood, Kelsey A. Jackson, Connor J. Kalhorn, Cecilia Myers, Thien Q. Tran, George Varghese, Laura A. Hansen, and Michael G. Nichols, Department of Physics, Creighton University, Omaha, NE 68178

Squamous cell carcinoma exhibits characteristics adapted to the hypoxic environments of tumors. According to the Warburg Hypothesis, it is generally observed that cancer cells adapt more glycolytic phenotypes in a high oxygen environment. Prior to this study, we had cultured SCC74B cells in a fully oxygenated (21%) environment, unrealistic with the conditions of the human body. We propose that the availability of oxygen throughout several weeks can change the effectiveness of energy usage in the processes of glycolysis and oxidative phosphorylation in cancer cells. To test this, two cell lines of SCC 74B High HER2 cells were cultured in closed chambers. One line treated with oxygen levels maintained at 3% and carbon dioxide levels maintained at 5% for several weeks. The second cell line was maintained at oxygen levels of 21%. For each line, coverslips were incubated at 37˚C for 35 minutes in three different treatment solutions: FCCP (mitochondrial uncoupled), routine imaging buffer, and rotenone (mitochondrial inhibited). Afterwards, the coverslips were taken to a confocal microscope for two-photon excited Phasor metabolic imaging. Measurements or NADH lifetime, NADH bound fraction, and intensity were then analyzed and compared between Low and High O2 SCC74B cells over the three treatment conditions. The same methods were repeated for two lines of SCC74A cells, which do not contain the HER2 gene. We found that the SCC74B cells in low oxygen (3%) grew 46% more quickly than cells at high atmospheric (21%) oxygen levels. The low O2 cells also had a significantly higher fraction of bound NADH than free. We could not conclude any significant differences in cellular growth for the SCC74Acells. However, theSCC74A line was more responsive to the effects of uncouplers and inhibitorsthan the SCC74B line. This publication was made possible by grants from the National Institute for General Medical Science (NIGMS) (5P20GM103427), a component of the National Institutes of Health (NIH), and its contents are the sole responsibility of the authors and do not necessarily represent the official views of NIGMS or NIH.

THE ANTIBIOTIC ACTIVITY OF THE LASSO PEPTIDE KLEBSIDIN AND ITS VARIANTS

Tyler J. Woodward, Department of Chemistry and Biochemistry, Creighton University, Omaha, NE 68178; Ethan Hills, Department of Genome Sciences, University of Washington, Seattle,WA 98195; Stanley Fields, Department of Genome Sciences, University of Washington, Seattle, WA 98195; Benjamin M. Brandsen, Department of Chemistry and Biochemistry, Creighton University, Omaha, NE 68178

The rise in antibiotic resistant infections is a serious and growing threat to public health, and the development of new antibiotics is critical to combat this rise. One potential source of new antibiotic compounds is ribosomally synthesized and post-translationally modified peptides (RiPPs). RiPPs are encoded in the genome, translated by the ribosome, and post-translationally modified by tailoring enzymes into unique chemical structures with diverse biological activities, including antimicrobial activity.

Lasso peptides are one class of RiPPs. Named for their threaded lariat structure, lasso peptides show excellent resistance to heat and proteases, making them attractive as potential therapeutics. These peptides can exhibit diverse biological functions, including antibioticactivity against prominent bacterial pathogens. To better understand this antibiotic activity, we performed a high-throughput assay to evaluate the antibiotic activity of amino acid variants of klebsidin, a lasso peptide from *Klebsiella pneumoniae*. We expressed these variants in *Escherichia coli* and tested their activity against this bacterium. The results of this assay revealed several positions where amino acid mutations are well-tolerated and antibiotic activityis maintained. From these data, we selected five variants to study more closely, evaluating theirexpression level, lasso peptide structure, and antibiotic activity. We found that each of these peptide variants expressed well, yielding at least 25% the level of the wild type peptide. We alsoverified using mass spectrometry that these variants are produced in the threaded lasso conformation, confirming that for these five variants, antibiotic activity does correlate with lassopeptide structure. Finally, we evaluated the antibiotic activity of each variant against *E. coli* expressing the FhuA transport protein from *K. pneumoniae*, which is thought to transport klebsidin into *K. pneumoniae*. We observed in each case a significant reduction in antibiotic activity for each peptide variant we tested compared to the wild type peptide. Given the robust antibiotic activity of these variants when expressed inside the cell, these findings suggest that entry into the cell is a significant contributor to the specificity of klebsidin's antibiotic activity.

COLLEGIATE ACADEMY: BIOLOGY

Chairperson: Therese McGinn, Nebraska Wesleyan University

FRIDAY, APRIL 23

MORNING SESSION - 1

7:45 ZOOM Session opens for participants to join https://nebrwesleyan.zoom.us/j/97662021070

8:00 WELCOME

8:05 EFFECTS OF DEUTERATED WATER ON LONGEVITY IN CANDIDA ALBICANS. Kai Johnson (abstract)

8:25 THE BIOLOGICAL CONTROL OF BACTERIAL LEAF STREAK OF CORN USING BACILLUS SUBTILIS AND BACILLUS PUMILUS. Katie J. Bathke, Charlene C. Jochum, and Gary Y. Yuen (abstract)

8:45 EXPLORATION OF CPTII KNOCKDOWN IN ZEBRAFISH. Carly Baker, Aaron Marta, Delaney Wilton, Andrew Kochvar, and Annemarie Shibata (abstract)

9:05 INTERACTION OF A PUTATIVE CHAPERONE WITH DOTA DURING AXENIC GROWTH OFCOXIELLA BURNETII. Joshua Lindenberger and Brandon Luedtke (abstract)

9:25 PHENOTYPIC PLASTICITY OF EGGLAYING IN TADPOLE SHRIMP IN RESPONSE TO CHANGING WATER HEIGHT. Alexander A. Piper (abstract)

9:45 GENETIC ANALYSIS OF INVASIVE JAPANESE BEETLES IN NEBRASKA. Jackson Petrzilka, Alexander De Pooter, Caitlin Duncan, Ethan Funke, Sarah Gregory, Isaac Richards, Abbey Brockhouse, Julia Brockhouse, and Charles Brockhouse (abstract)

10:00 **BREAK**

MORNING SESSION - 2

10:20 DETERMINING HOST-T4BSS INTERACTIONS OF COXIELLA BURNETII USING PROXIMITY LABELING. Samantha Mercer and Brandon Luedtke (abstract)

10:40 MEASURING GRANULOCYTE ACTIVITY TO UNDERSTAND THE POSSIBLE MECHANISM OF ACTION OF AN ANTISCHISTOSOMAL COMPOUND. Evie Ehrhorn, Samantha Sack, Caelyn Armshaw, and Paul H. Davis (abstract)

12:00 **LUNCH**

1:00 **BUSINESS MEETING** https://unl.zoom.us/j/97870996278
Nebraska Academy of Sciences (all members)

1:30-2:30 **MAIBEN LECTURE** https://unl.zoom.us/j/9289316099
Dennis Ferraro, *Reflections of a Nebraska Herpetologist*

COLLEGIATE ACADEMY: BIOLOGY ABSTRACTS

EXPLORATION OF CPTII KNOCKDOWN IN ZEBRAFISH

Carly Baker, Aaron Marta, Delaney Wilton, Andrew Kochvar, and Dr. Annemarie Shibata, Department of Biology, Creighton University, Omaha, NE 68178

Carnitine palmitoyltransferase II (CPTII) facilitates the conversion of palmitoylcarnitine to palmitoyl-CoA and is necessary for proper nervous system development. CPTII deficiency is associated with neurodevelopmental and neuropsychological disorders such as epilepsy, intellectual disabilities, and schizophrenia. We have recently published a case study report outlining CPTII deficiency in a proband diagnosed with schizophrenia. This case study underlies the rationale for these studies investigating how CPTII deficiency affects CNS development and function. We hypothesize that CPTII's role in the carnitine shuttle is essential for proper nervous system development and a loss of function of that system can promote neurological developmental issues and neuropsychological disorders. Microinjection of translation and splice-blocker morpholinos (0.5 μM) into 1 hpf zebrafish embryos demonstrate CPTII message and protein knockdown compared to scrambled, control morpholino injected embryos and wild type, injected embryos. Viability is influenced by CPTII knockdown. Compared to wild type (72.7% viability) and control viability (60.3% viability) 24 hpf post injection, translation blocker and splice blocker injected zebrafish exhibit 49.2% and 51.2% viability, respectively. 48 hpf viability for wild type was 70.8%, control injected was 53.2%, translation blocker was 46.5%, and splice blocker was 48.2% (n=100 per cohort). Phenotypic analysis of different embryonic conditions shows splice blocking embryos have a substantial amount of curved tails compared to control and wild type conditions (wild type 0.36%, control 6.98%, translation blocker 10.80%, and splice blocker 56.85%, n=20 per cohort). The percent of fish with shortened tails for wild type was 1.08%, control injected 3.32%, translation blocker 6.80%, and splice blocker 4.65% (n=20 per cohort). The percent of abnormal pigmentation for wild type was 8.63%, control injected 6.64%, translation blocker 8.80%, and splice blocker 19.92% (n=20 per cohort). Alcian Blue and Oil Red O staining of 5 dpf injected and uninjected embryos was completed and analyzed for cartilage development and lipid deposition. Huc/d staining was used to show differences in developing neurons while Wheat germ agglutinin was used for pan-neuronal staining. We have determined the knockdown of CPTII in the splice blocking morpholino injected embryos through the use of PCR and are working to confirm the knockdown of CPTII in the translation blocking morpholino injected embryos through Western Blotting. The study has successfully shown CPTII knockdown in splice-blocking and translation-blocking morpholino injected embryos. Future work will be focused on assessment of CPTII's role in CNS development through behavioral assays and electrophysiological experiments.

THE BIOLOGICAL CONTROL OF BACTERIAL LEAF STREAK OF CORN USING BACILLUS SUBTILIS AND BACILLUS PUMILUS

Katie J. Bathke, Charlene C. Jochum, Gary Y. Yuen, Department of Plant Pathology, University of Nebraska-Lincoln, Lincoln, NE 68588

Bacillus subtilis and *Bacillus pumilus* have been identified has a natural soil inhabiting plant growth promoting bacteria (PGPB) present in the rhizosphere. Plant growth promoting bacteria have a wide range of beneficial affects to the inhibition of pathogenic growth and development either direct or indirect mechanisms within the plant. Bacterial leaf streak (BLS) is

bacterial disease that affects the foliage of corn, caused by Xanthomonas vasicola pathovar vasculorum (Xvv). In this study, *Bacillus subtilis* and *Bacillus pumilus* were investigated for their activity against Xvv. in corn. *B. subtilis* and *B. pumilus* separately were applied to the seeds as seed inoculants in the for of bacterial suspensions. The corn was then grown in pots under greenhouse conditions to the late V3 – early V4 stage where it was then inoculated with the Xvv. The seed treatment of *B. subtilis* 6051 and *B. pumilus* R190 showed to reduce the severity in of bacterial leaf streak when compared to the untreated control. The findings suggest both strains of plant growth promoting bacteria has the potential to suppress the disease severity of bacterial leafstreak in corn.

MEASURING GRANULOCYTE ACTIVITY TO UNDERSTAND THE POSSIBLE MECHANISM OF ACTION OF AN ANTISCHISTOSOMAL COMPOUND

Evie Ehrhorn, Samantha Sack, Caelyn Armshaw, Dr. Paul H. Davis, Department of Biology,University of Nebraska at Omaha, Omaha, NE 68182

Schistosomiasis is a helminthic disease that affects more than 250 million people in endemic areas,as well as returning travelers. Schistosomiasis is the second leading cause of infectious disease morbidity only after malaria. Currently, the only available treatment for schistosome parasites is the drug praziquantel, which is only effective against the adult stage of the worm and not the juvenile stage. Due to increasing resistance to praziquantel and its limited effectiveness, it is crucial that other possible drug candidates be investigated. Fortunately, a new compound, EE1, with antischistosomal activity has proven effectiveness against both juvenile and adult worms in murine models of infection. The mechanism of this compound is unknown. We have applied techniques to provide insight into this anti-helminth activity, including electron microscopy, ELISA, and in vitro assays. Due to preliminary results, our work suggests the compound may function by inducing the host immune response.

EFFECTS OF DEUTERATED WATER ON LONGEVITY IN CANDIDA ALBICANS

Kai Johnson, Department of Biochemistry, University of Nebraska-Lincoln, Lincoln, NE 68588

Aging is a phenomenon that is experienced by all organisms and can be traced to irregularities at the subcellular level. Metabolic imbalances have been understood to contribute to the aging process, and thus they are a point of interest for research focused on understanding the mechanismsof aging. While factors of aging like oxidative stress have been traditionally explored through studying the role of reactive oxygen species (ROS), the role of other cytotoxic agents, like methylglyoxal (MG) are less studied. The yeast system (*Saccharomyces cerevisiae*) is an accepted model for aging because of its sequenced genome and relevant homologs for known aging genes. Among the aspects of decline in aging yeast is the decrease in the heavy isotope composition of abundant metabolites. As expected, the increased uptake of heavy isotopes has been found to increase chronological lifespan (CLS) of not only *S. cerevisiae*, but also *Candida albicans* (SC5314) and its MG detoxification mutant (Δglx3/Δglx3). My research aims to understand if deuterated water increases longevity through the reduction of cytotoxic compounds like MG. I plan to further explore this idea by testing the effects of deuterated water on the increased addition/accumulation of exogenous and endogenous MG.

INTERACTION OF A PUTATIVE CHAPERONE WITH DOTA DURING AXENIC GROWTH OF *COXIELLA BURNETII*

Joshua Lindenberger, Brandon Luedtke, Department of Biology, University of Nebraska at Kearney, Kearney, NE 68849

Coxiella burnetii is an intracellular pathogen that causes the zoonotic disease Q-fever. To infect eukaryoticcells and establish a replicative niche termed the parasitophorous vacuole (PV), *C. burnetii* uses a type IVB secretion system (T4BSS). The essential T4BSS component, DotA, is secreted from the bacterial cell and colocalizes with the PV membrane. However, it is unknown how the highly hydrophobic DotA is maintained within the bacterial cell cytoplasm prior to infection. Previously, we conducted a MALDI-TOF screen to identify proteins that potentially interact with DotA when *C. burnetii* is grown in axenic media. Three potential DotA interacting proteins, CBU_0351, CBU_1078, and HlyD were determined, based on molecular weight, to most likely interact with DotA in the cell cytoplasm. To determine a protein-protein interaction with DotA, the genes for the candidate proteins and *secB*, which was used as an alternative pathway control were fused to a 3xFLAG tag and expressed in *C. burnetii*. Western blot analysis revealed a potential interaction with CBU_1078-FLAG. A subsequent protein pull down and western blot indicates an intimate interaction of CBU_1078 with DotA. By elucidating a DotA chaperone could be used as a vaccine target for pathogens possessing a T4BSS.

DETERMINING HOST-T4BSS INTERACTIONS OF *COXIELLA BURNETII* USING PROXIMITY LABELING

Samantha Mercer, Brandon Luedtke, Department of Biology, University of Nebraska at Kearney, Kearney, NE 68849

Coxiella burnetii is a gram negative intracellular pathogen that causes the respiratory disease Q- Fever. During host cell infection, *C. burnetii* forms a parasitophorous vacuole (PV) from where it manipulates host cell processes. To mediate the infection an essential type IVB secretion system (T4BSS) is utilized. Interestingly, *C. burnetii* was shown to secrete the T4BSS protein DotA, which localized to the PV membrane. However, it is unknown if DotA interacts with host cell proteins as a part of the infectious process. To determine any DotA-host interactions, we chose to use proximity labeling, which has been used to show interactions between *Chlamydia trachomatis*effector proteins and the inclusion membrane. Here we constructed two expression plasmids that fused DotA to the promiscuous biotin ligase TurboID on either the N or C terminal. Wild type *C. burnetii* and the DotA knockout were transformed with the respective plasmids and then used to initiate tissue culture infections. In addition, western blot analysis proved that the bacteria were expressing the full DotA and TurboID fusion protein. When the tissue culture infections start to mature, we hope to identify the first interactions between the *C. burnetii* T4BSS and host cell proteins.

PHENOTYPIC PLASTICITY OF EGG LAYING IN TADPOLE SHRIMP IN RESPONSE TO CHANGING WATER HEIGHT

Alexander A. Piper, Department of Environmental and Earth Sciences, Doane University, Crete, NE

Triop longicaudatus (tadpole shrimp) can be found worldwide except in Antarctica and reside in many habitats including ephemeral pools. Tadpole shrimp that inhabit these pools are

threatened by environmental stressors that come with seasonal changes like precipitation and temperature. Changes in water levels impact the longevity of the pools and leave some pools to last only weeks.The variable nature of some temporary pools present the tadpole shrimp with great uncertainty of survival. Tadpole shrimp are well suited for this environment because of their characteristics suchas rapid life cycles and ability to reach sexual maturity as early as seven days. They also produce drought resistant eggs which in turn, enables them to endure the temporary pools' dry seasons. Tadpole shrimp are at risk of death before reaching sexual maturity and reproducing due to the unpredictable duration of the temporary pools. Therefore, temporary pools might leave tadpole shrimp with two possible options for maximizing reproduction fitness before death. First, tadpole shrimp could lay a few eggs as early as possible but also die early. Alternatively, they could live longer by laying fewer eggs early but ultimately growing larger and thus lay more eggs in a lifetime.The trade-off is a few eggs early or lots of eggs later. In order to carry out these strategies, tadpoleshrimp should be able to assess their environment and detect changes. This project aims to test whether or not tadpole shrimp alter egg-laying behavior in response to changes in water availability. We tested tadpole shrimp egg laying behavior against two treatments, one treatment with an increase in water levels and the other with a reduction in water levels. Results of the experiment have shown that alteration in water levels induces early egg laying behavior in tadpole shrimp.

GENETIC ANALYSIS OF INVASIVE JAPANESE BEETLES IN NEBRASKA

Jackson Petrzilka, Alexander De Pooter, Caitlin Duncan, Ethan Funke, Sarah Gregory, Isaac Richards, Abbey Brockhouse, Skutt Catholic High School Biotechnology Research Club, Omaha, NE 68130; Julia Brockhouse, Parks College of Engineering, Aviation, and Technology, Saint Louis University, St. Louis, MO, 63103; Charles Brockhouse, Biology Department, Creighton University, Omaha, NE 68131

The Japanese Beetle, *Popillia japonica*, is an invasive insect that has become established in Nebraska as a significant pest, especially of fruit trees and ornamentals in domestic gardens. The Skutt Catholic High School Biotechnology Club initiated a study to ultimately sequence the mitochondrial DNA from samples of *P. japonica* collected in Omaha, laying the foundations to understand the population structure and origin of the Nebraska population. Several DNA isolation methods were compared to prepare DNA for MinION (Oxford Nanopore) nanopore sequencing. As preliminary MinION runs of total genomic DNA did not provide sufficient coverage to produce a mitochondrial DNA consensus sequence, we used the Long PCR technique to selectively amplify entire mitochondrial genomes prior to sequencing. Here we report progress in cloning and sequencing of mitochondrial genomes, and present future plans for studying the genetic structure of the population.

COLLEGIATE ACADEMY: CHEMISTRY & PHYSICS

Chairperson: Nathanael Fackler
Nebraska Wesleyan University

FRIDAY, APRIL 23

MORNING SESSION - 1

7:45 ZOOM Session opens for participants to join https://unl.zoom.us/j/9289316099

8:00 WELCOME. **Speakers:** *Please note that presentations are limited to 15 minutes, including any questions. 5 minutes are reserved between presentations for speaker "setup".* **Audience:** *Please mute your audio during the presentations. During the question period (f time allows) you may unmute your audio and pose your question. Additionally you may post your question(s) to the chat. The session chair reserves the right to manage question order if simultaneous questions arise. Once the speaker's time is complete, I ask that additional questions be directed to the speaker via the direct chat option (if enabled).*

8:05 NEW METHODS FOR THE SYNTHESIS OF FUNCTIONALIZED ETHERS VIA PEROXIDES AS A SOURCE OF ELECTROPHILIC OXYGEN. Amber Schuster and Pat Dussault (abstract)

8:25 MATRIX ANALYSIS OF CONTROLLED EVAPORATION MIXING (CEM) LIQUID DETECTOR FOR STGC AT STAR EXPERIMENT. Rebecca Powers (abstract)

8:45 DESIGN, CONSTRUCTION, AND OPERATION OF AN ACOUSTIC DOUBLE-SLIT EXPERIMENT. Owen Root, Xander Schmidt, Vanessa Wergin and Maria Becker (abstract)

9:05 ACOUSTIC DOUBLE-SLIT PROJECT – SENSOR CIRCUIT DESIGN. Xander Schmidt, Owen Root, Vanessa Wergin, and Maria Becker (abstract)

9:25 ACOUSTIC DOUBLE-SLIT EXPERIMENT: DATA COLLECTION AND PYTHON VISUALIZATIONS. Vanessa Wergin, Owen Root, Xander Schmidt, and Maria Becker (abstract)

9:45 NANOPARTICAL PALLADIUM CATALYTIC HYDROGENATION OF CYCLOPROPANE. Katie Cunningham, Kara Grossman, Grace Recker, Kenzie Enmeier, and Bruce Matson (abstract)

10:00 **BREAK**

MORNING SESSION - 2

10:20 THE HYGROSCOPIC PROPERTIES OF AMMONIUM SULFATE-AMINO ACID AEROSOLS. Chase Stebbing, Kain Mitts, and Dr. Darr (abstract)

10:40 INVESTIGATION OF RUTHENIUM COMPLEX ELECTROCHEMILUMINESCENCE AT GOLD ELECTRODES MODIFIED WITH DIFFERENT CHAIN LENGTH ALKANETHIOLS. Samaya Kallepalli, Jacob Benes, Dr. Gross, Kennith Hipp, and Dr. Rebecca Lai (abstract)

12:00 **LUNCH**

1:00 **BUSINESS MEETING** https://unl.zoom.us/j/97870996278
Nebraska Academy of Sciences (all members)
State of the Academy
Awards Ceremony
Vote by NAS members on Revisions to NAS Constitution
Comments from Members-at-Large

1:30-2:30 **MAIBEN LECTURE** https://unl.zoom.us/j/9289316099
Dennis Ferraro, *Reflections of a Nebraska Herpetologist*

NANOPARTICAL PALLADIUM CATALYTICHYDROGENATION OF CYCLOPROPANE

Katie Cunningham, Kara Grossman, Grace Recker, Kenzie Enmeier, and Bruce Mattson, Department of Chemistry, Creighton University, Omaha, NE 68178

Cyclopropane undergoes hydrogenation anddeuteration in the presence of a nanoparticle palladium catalyst (0.5% on alumina) at elevated temperatures. Cyclopropane adsorption on the Pd surface leads to C-C bond rupture at T > 175 ºC with formation of two σ-bonds to Pd utilizing C1 and C3. In the case of deuteration, extensive and probably statistical D/H exchange takes place through σ-propyl[Pd] and η^3-propyl[Pd] intermediates. Cyclopropane can rearrange to propene at very high temperatures if hydrogen is not present.

INVESTIGATION OF RUTHENIUM COMPLEX ELECTROCHEMILUMINESCENCE AT GOLD ELECTRODES MODIFIED WITH DIFFERENT CHAIN LENGTH ALKANETHIOLS

Samaya Kallepalli, Jacob Benes, Erin M. Gross, Department of Chemistry, Creighton University, Omaha, NE 68178; Kenneth Hipp, Rebecca Y. Lai, Department of Chemistry, University of Nebraska-Lincoln, Lincoln, NE 68588

Previous work in our lab has demonstrated the fabrication of electrochemiluminescent (ECL) folding-based nucleic acid biosensors using tris (2,2'-bipyridyl)ruthenium(II) chloride ($Ru(bpy)_3^{2+}$). Experimental conditions were optimized to develop sensors with improved ECL signals and stability. However, some sensors still exhibited irreproducibility under some experimental conditions. Alkanethiols are used as the passivation layer after dropcasting DNA aptamers onto the electrode surface and must remain stable, along with the DNA aptamer, duringthe interrogation potential. This study investigated which conditions lead to the largest and moststable ECL signals when an electrode is modified with only a monolayer of alkanethiol. Electrodes were fabricated with alkanethiol monolayers of either eight (C8) or nine (C9) carbon chains and immersed in a pH 7.4 buffer solution containing 1-μM $Ru(bpy)_3^{2+}$ and the co-reactant100-mM tri-n-propylamine. Cyclic voltammetry-ECL traces were collected to determine the potential of maximum ECL. The onset of ECL was observed at around 0.65 V for each electrodewith a peak intensity around 0.85 V (vs. Ag, AgCl). Chronoamperometry (CA)-ECL traces were collected in order to: investigate ECL as a function of potential, observe the ECL temporal profile and to measure the reproducibility of the ECL signal. Through CA, potentials of 0.70 V, 0.75 V, 0.80 Vand 0.85V were applied at each electrode while ECL was monitored. From the ECL-time traces, both C8 and C9 electrodes exhibited signals of similar intensities at the same respective potentials.There were no significant differences between the electrodes of the varying chain lengths,however, the C8 electrodes showed a faster ECL response than the C9 electrodes.We also observed the ECL signal intensity to increase with increasing applied potential, until thethresholdof 0.85 V, where the signal became unstable. The capacitance of each electrode was determined at various timepoints during the experiment in order to determine monolayer stability. The electrodes exhibited relatively constant capacitances through all trials, confirming that the alkanethiol monolayer remained intact after the application of varying potentials. The most reproducible signals were observed at 0.70 V and 0.75 V, and the signal became progressively unstable as

potential increased to 0.85 V. Through this work we will determine the optimal alkanethiol chain length and applied potential to use in folding-based ECL nucleic acid biosensors.

MATRIX ANALYSIS OF CONTROLLED EVAPORATION MIXING (CEM)LIQUID DETECTOR FOR STGC AT STAR EXPERIMENT

Rebecca Powers, Department of Physics, Creighton University, Omaha, NE, 68178

The Solenoidal Tracker (STAR) at Brookhaven National Laboratory is a large detector system built for the detection of quark gluon plasma formation at the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory. A crucial component of the STAR detectoris the Forward Tracking System (FTS), which is responsible for measuring the momenta of charged particles traveling out from a collision at RHIC. The STAR FTS requiresa precise mixture of gases to operate at 290.15 K for optimal performance. A new small strip thin gas chamber (STGC) is being implemented at the STAR FTS, containing a gas mixture of45% *N*- pentane and 55% carbon dioxide. N-pentane is a very flammable liquid, and so an excess of this component in the mixture would significantly increase combustion hazards. Because of the chemical properties of the gaseous mixture, an excess of pentane in the mixturewill cause it to condense and drip into a liquid detection system. The implementation of a new alarm system based on detecting this condensed liquid will prevent an excess of pentane operating in the mixture, preventing a possible combustion hazard in the STAR FTS. This presentation specifically focuses on the design of a MATLAB matrix to model the gaseous equilibrium within the STGC, to confirm the gaseous composition at the given temperature andpressure.

DESIGN, CONSTRUCTION, AND OPEREATION OF AN ACOUSTIC DOUBLE-SLITEXPERIMENT

Owen Root, Xander Schmidt, Vanessa Wergin, and Maria Becker, Department of Physics, Nebraska Wesleyan University, Lincoln, NE 68504

The quantum world of waves can be a difficult realm to understand and an even harder one to investigate experimentally. However, there are other waves that are more readily accessible; one such type of wave being sound. We can easily study sound waves and can therefore use them as a useful model of certain quantum wave properties. By using an apparatusto create an acoustic double-slit with certain controls over the nature of the created sound waves,it is possible to emulate and explore dephasing and decoherence. These two quantum processesremove the ability of waves to interfere. Without interference, quantum technology such as quantum computers, won't function. Thus, furthering our understanding of dephasing and decoherence is important for continued progress in this field. This presentation covers the design and construction of our experimental apparatus, and its use so far in collecting preliminary data.This work is supported by the Nebraska EPSCoR program (grant no. OIA-1557417).

ACOUSTIC DOUBLE-SLIT PROJECT – SENSOR CIRCUIT DESIGN

Xander Schmit, Owen Root, Vanessa Wergin, and Maria Becker, Department of Physics, Nebraska Wesleyan University, Lincoln, NE 68504

The objective of the Acoustic Double Slit project is to create an acoustic analogue of the quantum double-slit experiment. The apparatus being constructed will not only to provide a visualization of the inference pattern but will also have the capability to emulate quantum decoherence and dephasing. Two 40 kHz speakers are being used as "slits" and an accompanying receiver detects the time-dependent interference pattern. The familiar double-slit interference pattern, seen for example in experiments involving light or electrons, is time- averaged. To record the time-averaged interference pattern in our experiment, a voltage rectifiercircuit was designed and is currently being implemented. The primary components of the circuit,including a bandpass filter, an amplifier, a bridge rectifier, and an Arduino, will be discussed. Preliminary results will also be shared. This work is supported by the Nebraska EPSCoR program (grant no. OIA-1557417).

NEW METHODOLOGY FOR THE SYNTHESIS OF FUNCTIONALIZED ETHERS VIAPEROXIDES AS A SOURCE OF ELECTROPHILIC OXYGEN

Amber Schuster and Professor Patrick H. Dussault, Department of Chemistry, University of Nebraska-Lincoln, Lincoln, NE 68588

The formation of ethers (C-O-C) and silyl ethers (C-O-Si) through reaction of nucleophilic oxygen, typically in the form of species derived from alcohols, with electrophilic carbon or silicon, has been extensively studied. The use of dialkyl peroxides as precursors for generationof ethers or silyl ethers is not as well known. In particular, while reactions of dialkyl peroxideswith heteroatom and organometallic nucleophiles have been reported, understanding of the factors controlling peroxide reactivity, and application of the methods, remains limited. Previous work in the lab has found that monoperoxyacetals of alkyl hydroperoxides areexcellent electrophiles for C-O bond formation, possessing a useful combination of ease of handling, thermal stability, and reactivity. We are now interested in exploring the reaction of peroxides, including peroxyacetals, with heteratom nucleophiles possessing anionic silicon, phosphorus, or tin, as a new approach to the synthesis of Si-O, P-O, and Sn-O linkages. This presentation will provide background on the challenge and discuss our initial results in this area.

THE HYGROSCOPIC PROPERTIES OF AMMONIUM SULFATE-AMINO ACID AEROSOLS

Chase Stebbing, Kain Mitts, Joshua P. Darr, Department of Chemistry, University of Nebraska at Omaha, DSC 337, 6001 Dodge St, Omaha, NE, 68182

Salts have hygroscopic properties that describe their interactions with water in ways outside of simply dissolving, such as efflorescence (the ability for a salt to crystalize from an aqueous state) and deliquescence (the ability for a salt to absorb water from the humid air). In small aerosol particles, it has been found that organic material, such as amino acids like glycine and alanine, mixed with the salts can sometimes change their hygroscopic properties.

Ammonium sulfate (AS) is being studied currently because it is commonly found as fertilizer,and because both ammonium and sulfate ions, or their protonated/deprotonated versions,

are commonly found in pollutants. The AS-amino acid aerosols are conditioned to a specific relative humidity and sent into a flow cell. A Fourier transform infrared spectrometer measuresthe extinction of IR radiation by the aerosols in the flow cell. In previous studies, consistent with their hydrophilic and hydrophobic properties, respectively, it has been found that sodiumchloride mixed with glycine undergoes continuous hygroscopic growth, while the NaCl- alanine mixture does not. While the AS-glycine mixture behaves similarly, interestingly, the AS-alanine mixture also appears to undergo continuous hygroscopic growth in spite of alanine's hydrophobic properties.

ACOUSTIC DOUBLE-SLIT EXPERIMENT: DATA COLLECTION AND PYTHON VISUALIZATIONS

Vanessa Wergin, Owen Root, Xander Schmidt, and Maria Becker, Departmentof Physics, Nebraska Wesleyan University, Lincoln, NE 68504

The famous double-slit experiment has been used to demonstrate the wave like nature of light and electrons. The purpose of this research project is to reproduce the double-slit experiment tusing acoustic waves, with a further goal to investigate quantum decoherence. The focus of my work as part of the research team surrounds implementing a distance sensor for datacollection and working with Python to create a computer simulation of the experiment. I utilizeda Micro-LIDAR distance sensor with an Arduino to collect positional data for the microphone signal. Implementing the concept of wave interference applied to the dimensions of our structure,I wrote Python code to visualize two-dimensional time-dependent interference patterns. This work is supported by the Nebraska EPSCoR program (grant no. OIA-1557417).

EARTH SCIENCES

Chairperson: Irina Filina, University of Nebraska-Lincoln

FRIDAY, APRIL 23

MORNING SESSION - 1

8:15 ZOOM Session opens for participants to join https://unl.zoom.us/j/92427665398

8:30 WELCOME

8:35 AN ANALYSIS OF FLOOD THAT OCCURRED IN KEARNEY, NEBRASKA, IN JULY 2019. Vijendra Boken and Payton Livengood (abstract)

8:55 RADIOMETRIC DATING OF CANYON FILLS CONSTRAINS LATE HOLOCENE GEOMORPHIC EVOLUTION OF THE PINE RIDGE AT CHADRON, NEBRASKA. Michael B. Leite and Steve Welch (abstract)

9:10 NUTRIENT INFILTRATION. Paige Vitosh, Tim Keith, and Mary Keithly (abstract)

9:30 ESTABLISHING NEW GRAVITY BASE STATION IN LINCOLN, NE. Kris Guthrie and Irina Filina (abstract)

9:45 RELOCATING HYPOCENTERS OF THE 2018 EARTHQUAKE CLUSTER IN CENTRAL NEBRASKA. Irina Filina and Kris Guthrie (abstract)

10:00 **BREAK**

MORNING SESSION - 2

10:20 IMPACT OF GREATER PRECIPITATION DURING HEAVY EVENTS ON RECHARGE AND CROP PRODUCTION IN NEBRASKA. Celeste S Kenworthy, Vaishali Sharda, and Erin MK Haacker (abstract)

10:40 A SYNOPSIS OF FAVORABLE ENVIRONMENTS FOR SUPERCELL THUNDERSTORMS AND TORNADOES. Kyle Pittman, Kristen Axon, Dan Butler, Devon Healey, and Matthew Wilson (abstract)

11:00 EXTREME SUPERSATURATION IN CESM2 AND E3SM SIMULATIONS: SENSITIVITY TO TIME-STEPPING. Ross Dixon, Xubin Zeng, Shixuan Zhang and Hui Wan (abstract)

11:20 THE DIATOM DARK AGES: IDENTIFICATION OF MID-CRETACEOUS ARCTIC PLATFORM DIATOMS FROM THE BASAL TRANSGRESSIONS OF THE KANGUK FORMATION, DEVON ISLAND, NUNAVUT, CANADA. Megan Heins and David M. Harwood (abstract)

11:40 MICROABLATION SPHERULES AND THE ELTANIN METEOR IMPACT: STRATAGRAPHIC DATING OF DIATOM FOSSILS AND TEKTITES IN ROSS SEA SEDIMENT CORES TO ASSESS AND DATE THE INTENSIFICATION OF ANTARCTIC GLACIATION. Rylan Chilcott and David Harwood (abstract)

12:00 **LUNCH**

1:00 **BUSINESS MEETING** https://unl.zoom.us/j/97870996278
Nebraska Academy of Sciences (all members)
State of the Academy
Awards Ceremony
Vote by NAS members on Revisions to NAS Constitution
Comments from Members-at-Large

1:30-2:30 **MAIBEN LECTURE** https://unl.zoom.us/j/9289316099
Dennis Ferraro, *Reflections of a Nebraska Herpetologist*

AFTERNOON SESSION - 3

2:50 p.m. ZOOM Session is open for participants to join https://unl.zoom.us/j/92427665398

3:00 GEOLOGICAL STRUCTURES AND CRUSTAL ARCHITECTURE OF JUAN DE FUCA PLATE FROM SEISMIC DATA. Khawlh Al Farsi and Sulaiman Al Badi, Asif Ashraf and Irina Filina (abstract)

3:20 MAJOR TECTONIC STRUCTURES OF JUAN DE FUCA PLATE FROM INTEGRATION OF SEISMIC, GRAVITY AND MAGNETIC DATA. Asif Ashraf and Irina Filina (abstract)

3:40 CONTROLS ON THE SELECTIVE REACTIVATION OF BASEMENT STRUCTURES: OBSERVATIONS FROM A BACK-ARC RIFT SYSTEM FORMED IN THE TARANAKI BASIN, OFFSHORE NEW ZEALAND. Shashank Khatri and Caroline M Burberry (abstract)

4:00 INTEGRATED GEOPHYSICAL MODELING OVER BATHYMETRISTS SEAMOUNTS. Alexa Fernández and Irina Filina (abstract)

4:20 NEOGENE TO RECENT FAULT REACTIVATION IN SOUTHERN VIETNAM, IMPLICATIONS FOR MODERN DAY EXTRUSION OF INDOCHINA AND MICROBLOCK ROTATION WITHIN THE CORE OF THE SUNDALAND BLOCK. Nicholas Richard, Caroline M Burberry, Lynne J Elkins, Le Duc Anh, and Nguyen Hoang (abstract)

GEOLOGICAL STRUCTURES AND CRUSTAL ARCHITECTURE OF JUAN de FUCA PLATE FROM SEISMIC DATA

Khawlh Al Farsi, Asif Ashraf, Sulaiman Al Badi, Irina Filina, Department of Earth and Atmospheric Sciences, University of Nebraska-Lincoln, Lincoln, NE 68588

This paper focuses on developing a geophysical database of publicly available seismic reflection and refraction surveys over the Cascadia subduction zone. In that region, the oceanic Juan de Fuca plate subducts underneath the North American continent. A devastating megathrust earthquake is expected at this margin that will affect the population of the northwestern U.S. and Canada. It is important to understand the geology of this active tectonic boundary in order to comprehend the overall subduction process and associated seismic hazards.Our database consists of eight publicly available seismic reflection surveys that were acquired between 1964 and 2017. The total length of seismic reflection records used in this study is morethan 7000 km. The thickness of sedimentary cover varies from zero over the Juan de Fuca spreading center to up to 6km near the deformation front. Seismic imaging is challenged over the subduction zone due to high variability in velocities of deformed sedimentary rocks, so the base of the accretionary prism is not imaged confidently. In contrast, the acoustic basement canbe traced reliably between the spreading center and the deformation front, allowing us to map multiple highs and lows. We have also interpreted several seamounts that deepen away from thespreading center. In addition to seismic reflection surveys, we have included several seismic refraction profiles that utilize instruments onshore and offshore Oregon and Washington states. The gathers from those instruments are combined in three velocity cross-sections extending fromthe deformation front to the Cascade volcanic arc. The oceanic crust of the Juan de Fuca plate isapproximately 7 km thick. The accretionary prism reaches a thickness of 15 km. The accretionary complex widens from approximately 100 km in Oregon to more than 200 km in Washington. Seismic refraction cross-sections in our database suggest that subducting slab dips up to 14˚ degrees. The thickness of the accreted Siletz terrain is about 32 km at both Washington and Oregon margins. The depth to Mohoboundary in continental domain ranges between 33 and 35km from south to north. The composed database will be used for future modeling of major subsurface geological structures over the Cascadia subduction zone. Documented structural features and crustal architecture of this active tectonic margin are important to understand the ongoing geology and to prepare for an imminent megathrust earthquake.

MAJOR TECTONIC STRUCTURES OF JUAN DE FUCA PLATE FROM INTEGRATION OF SEISMIC, GRAVITY AND MAGNETIC DATA

Asif Ashraf, Irina Filina, Department of Earth and Atmospheric Sciences, University of Nebraska-Lincoln, Lincoln, NE 68588

This study investigates major geologic features of the Juan de Fuca (JDF) plate, namely seamounts and pseudofaults, via the integration of multiple geophysical datasets. This plate subducts beneath the western coast of the North American continent, posting the margin to a risk of an imminent catastrophic megathrust earthquake. Furthermore, variations in seismicity along the subduction zone are observed as fewer earthquakes are recorded over the Oregon portion

of the margin with respect to adjacent regions. The relationships between this unique seismicity zonation and geological structures of both subducting and overriding crusts are still poorly understood. Due to a thick prism of sediments on top of subducting JDF plate, both seismic reflection and refraction surveys are unable to fully examine the crustal architecture of the marginand physical properties of subsurface rocks. In this research, previously interpreted propagator wakes and newly mapped pseudofault lineaments and seamounts on JDF plate are characterized from potential fields (gravity and magnetic) and seismic datasets.

Pseudofault lineaments were mapped based on two specific criteria, namely, they followed discontinuity in the seafloor magnetic strips, and were associated with lower-density crustal rocks established from regional 2D integrated models. The latter suggests that these geologic structures represent zones of crustal weakness within an oceanic plate that should influence the subduction process. Buried seamounts were other geologic structures that have been mapped from seismic and potential field data. Their magnetic signatures are obscured by pronounced magnetic reversals, so no unique magnetic attributes for seamounts were established. In contrast, filtered Bouguer gravity anomaly shows distinctive gravity lows over known seamounts. Basedon this observation, several previously unknown buried seamounts were mapped on the JDF plate. Seamounts appear to be clustered around identified pseudofault lineaments and propagatorwakes, suggesting that those act as conduits for magma, which is in turn consistent with these regions being zones of weakened oceanic crust. Understanding various crustal features of the JDF plate is important as they influence the overall subduction process and may be responsiblefor the observed seismicity pattern.

AN ANALYSIS OF FLOOD THAT OCCURRED IN KEARNEY, NEBRASKA, IN JULY 2019

Vijendra Boken and Payton Livengood, Department of Geography, Universityof Nebraska at Kearney, Kearney, NE 68849

An unusual flood occurred in Kearney on July 9, 2019. A thunderstorm dump on July 8, 2019, raised water levels quickly in the creeks and the rivers passing near Kearney and flooded certain areas in Kearney. Many people were evacuated, and the flood caught the city off guard. Many businesses and private homes in the city were badly affected and suffered heavy economic losses. In the present study, the data available for the potential creeks or rivers were collected for a historical period and analyzed to determine flood frequencies and the return periods knowledge of which would be helpful to prevent such floods in the future.

MICROABLATION SPHERULES AND THE ELTANIN METEOR IMPACT: STRATAGRAPHIC DATING OF DIATOM FOSSILS AND TEKTITES IN ROSS SEA SEDIMENT CORES TO ASSESS AND DATE THE INTENSIFICATION OF ANTARCTIC GLACIATION

Rylan Chilcott, David Harwood, Department of Earth and Atmospheric Sciences, University of Nebraska-Lincoln, Lincoln, NE 68588-0340

Micro-ablation spherules have been detected in sediment from ocean-floor drill cores taken from International Ocean Discovery Program (IODP) Expedition 374 at several sites in the Ross Sea, Antarctica. Ablation spherules form as meteorites vaporize when passing through the atmosphere, releasing microscopic fragments that accumulate in marine sediments. Spherules can

be isolated from sediment samples and subjected to gas-spectroscopy to determinetheir chemical composition. Multiple samples from a stratigraphic series can be compared to determine whether the ablation spherules are derived from many different meteorite sources or from a single event. An alternative explanation for the micro-spherules is that they derive froma meteorite impact event that vaporized marine sediments, which should carry a uniquegeochemical fingerprint. Current scientific understanding of the reasons for Antarctic glaciationand onset of the Quaternary Ice Age in the late Pliocene is still incomplete and requires further study. Debate continues as to whether the Eltanin meteor impact in the Bellingshausen Sea in the SE Pacific Ocean, off the Antarctic margin was partly responsible for this global shift toward glacial conditions on Earth. By documenting the occurrence and composition of microtektites in deep-sea sediment cores, a more precise date can be attributed to the Eltanin meteor impact, an event that has been implicated in Late Pliocene cooling that led to increased Antarctic coolingand glaciation. Climate conditions that led to this period of glaciation can be used as models to help us understand what might be in store for the present times, as CO_2 levels between the two time periods are similar. The stratigraphic distribution of micro-spherules and their size spectrum and abundance will provide new information on the oceanographic processes, variations in current strength, and potential changes in source regions that are providing the spherules. It is anticipated that glacial erosion and transport, as well as ocean current depositionalprocesses, have played a role in the present distribution of micro-spherules in these stratigraphiccores. Diatom biostratigraphy in paired sediment samples will provide age control for the depositional sequences.

EXTREME SUPERSATURATION IN CESM2 AND E3SM SIMULATIONS: SENSITIVITY TO TIME-STEPPING

Ross Dixon, Department of Earth and Atmospheric Sciences, University of Nebraska-Lincoln, Lincoln, NE 68588; Xubin Zeng, Department of Hydrology and Atmospheric Sciences, Universityof Arizona, Tucson, AZ 85721; Shixuan Zhang, Hui Wan, Pacific Northwest National Laboratory, Richland, WA 99354

Supersaturated regions, where relative humidity (RH) with respect to ice or liquid water is greater than 100%, are observed in ice and mixed-phase clouds. Regions of strong supersaturation can impact the upper troposphere through latent heat release and interaction withradiation. It is therefore desirable that our global climate models are able to produce values of RH greater than 100%, but important that they do so for the correct reasons and that they do notproduce values of RH much greater than seen in observations. Simulations performed with the default configuration of NCAR's Single Column Atmospheric Model (SCAM6; Gettleman et al.2019) produce RH values greater than 110% with respect to liquid water and greater than 200%with respect to ice. These extreme values of supersaturation are also seen when running the full CESM2 with CAM6physics. When the time step for the model microphysics is shortened fromits default value, the extreme values of RH are decreased. To assess the robustness of these results, we will also repeat these experiments using the SCM and full model of the DOE Earth System Model (E3SMv1).

INTEGRATED GEOPHYSICAL MODELING OVER BATHYMETRISTSSE AMOUNTS

Alexa Fernández, Irina Filina, Department of Earth and Atmospheric Science, University of Nebraska-Lincoln, Lincoln, NE 68588

The Bathymetrists Seamounts (BSM) are located in the Atlantic Ocean north of the Sierra Leone Rise (SLR). The southwest to northeast trend of these seamounts is controversial to the current eastward motion of the African tectonic plate. In addition to this apparent mismatch, the origin and crustal architecture of these intriguing seamounts are poorly understood. The goal of this study is to develop an integrated geophysical model of the BSM and SLR crustal blocks in order to better understand the geological structures and tectonic history of the seamounts as well as comprehend their relationship with the adjacent Sierra LeoneRise.

A seismic refraction study from Jones et al. (2015) was used as a framework for this research. This data set suggested magmatic underplating under the SLR but failed to determine the crustalthickness of the BSM block. Isostatic modeling was developed based on that study in order to find possible constraints for crustal structures beneath the BSM. This was done by balancing pressures underneath the SLR and BSM crustal blocks, concluding that magmatic underplating below the BSM block is a crucial element for the model to work. Based on that analysis, a new hypothesis was developed suggesting these blocks were formed at the same time over the same source. Then, they were offset more than 100 km by a hypothetical right-lateral transform fault striking southwest to northeast, similarly to the observed trend of the seamounts. The seamounts thus developed from magmatic activity at the time this fault was active.

This study builds up on the isostatic model via integration of seismic and potential fields data. The two-dimensional subsurface model was developed based on seismic reflection profile over both the BSM and SLR regions to test possible crustal architectures that satisfy observed gravityand magnetic signatures. The developed model confirms that the presence of ~5 and 6 km of magmatic underplating beneath the BSM and SLR respectively is essential to satisfy gravity anomaly.

The integration of different geophysical data sets increases the confidence of the derived subsurface structures. The next step is to include magnetic data into the analysis to improve the subsurface model and make it more robust.

RELOCATING HYPOCENTERS OF THE 2018 EARTHQUAKE CLUSTER IN CENTRAL NEBRASKA

Irina Filina, Kris Guthrie, Department of Earth and Atmospheric Sciences,
University of Nebraska-Lincoln, Lincoln, NE 68588

A swarm of 27 earthquakes occurred near Arnold, Nebraska, from April to December 2018. All the earthquakes were clustered in a 10 x 10 km region in Custer County. The equivalent moment magnitudes ranged from 2 to 4.1. No injuries were reported, although some notifications about ground shaking were sent to the U.S. Geological Survey (USGS) by people from as far away as Lincoln and Omaha. Our prior studies suggest that this sudden release of seismic energy relates to the reactivation of a previously unknown basement fault system believed to be associated withthe Midcontinent Rift which formed in the Proterzoic. The causeof its sudden reactivation in 2018 remains unknown. The USGS determined the depth of hypocenters to be shallow with most events having an assigned 5 km depth, indicative of large uncertainty in that parameter. We have evaluated the records from the three nearest seismic stations: Ogalala (OGLE), Basset (K30B), and Belgrade (BGNE). We noticed significant discrepancies between the observed and USGS-estimated P- and S-waves' arrival times in seismic records. The primary objective of this study is to invert the observed arrivals of body waves in order to improve the focal locations of all earthquakes in the cluster. We utilized a simulated annealing inversion algorithm that allowed us

not only to derive the hypocenters andvelocities of P- and S-waves in both sedimentary cover and the upper crust but also to estimatethe uncertainty of the derived solution. Our inversion results in a better match between observed and computed arrival times for all three seismic stations. Our relocated hypocenters form a tighter cluster. The inverted focal depths range from 1.1 to 9.5 km and make the fault plane more apparent. Our inversion improved the accuracy of each relocated hypocenter to be within 1.5 km in the horizontal plane and 2.5 km in depth. The relocated earthquakes will be used to guide a future geophysical survey over the region of clustered seismicity to map the fault system and understand the reason for its sudden reactivation.

ESTABLISHING NEW GRAVITY BASE STATION IN LINCOLN, NEBRASKA

Kris Guthrie, Irina Filina, Department of Earth and Atmospheric Sciences,
University of Nebraska-Lincoln, Lincoln, NE 68588

Absolute gravity base stations are necessary to tie measurements taken during gravity surveys. In Lincoln, the KLNK unofficial gravity marker is located on the Lincoln airport tarmac which makes it challenging to access for routine measurements. Two surveys conducted by the UNL Geophysics Team using the KLNK marker revealed a gigantic mismatch of approximately 40 mGal between the collected gravity data and the published USGS values. Due to the accessibility issues of the KLNK marker and the apparent mismatch that needs to be explained, a new absolute gravity base station in a publicly accessible location on the UNL city campus will be established. This study focuses on choosing a potential site for a new gravity marker that has a low-noise level and is accessible by anyone. The absolute gravity values from nearby, already existing gravity base stations in Hastings and Geneva, NE are being transferred.

We initially identified four potential locations with two inside of Bessey Hall and two outside but nearby. We eliminated the two inside options after the Covid-19 pandemic illuminated problems with accessing them. The two remaining locations are at the base of thestairs at the entrance to the UNL State Museum and in front of the Mueller Tower. Regular measurements have been conducted at these locations since 2019. Overall, 54 measurements at the Mueller Tower and 55 measurements at the State Museum were performed. The standard deviations of these readings, representing the noise levels, are 38 and 36 μGal respectively. To transfer the absolute gravity value, five trips to Hastings and Geneva have been completed between September 2020 and March 2021. The results show that the mismatch associated with the KLNK marker is due to an error in the absolute gravity valuewe received from NOAA's 2013 survey. Based on our measurements a mismatch up to 157μGal (0.157 mGal) between the Hastings and Geneva base station is observed. More investigation is needed to determine which one is more reliable.

THE DIATOM DARK AGES: IDENTIFICATION OF MID-CRETACEOUS ARCTIC PLATFORM DIATOMS FROM THE BASAL TRANSGRESSIONS OF THE KANGUK FORMATION, DEVON ISLAND, NUNAVUT, CANADA

Megan Heins, David M. Harwood, Department of Earth and Atmospheric
Sciences, University of Nebraska-Lincoln, Lincoln, NE 68588

The mid-Cretaceous presents us with many different questions surrounding marine diatom evolution, environmental distribution, and paleobiogeography. Diatom assemblages have been studied extensively from the late Cretaceous onwards, with less information from the early Cretaceous, but not much is known about mid-Cretaceous diatom assemblages. This time interval

reflects a gap in our knowledge and understanding of diatom evolution and biostratigraphy. Most importantly, connections between ancestral, archaic, medial, and modern diatom records are missing. Without these connections, little can be inferred about environmental and ecological changes based on diatoms during this time. The main purpose ofthis thesis project is to examine sediment samples from the Arctic Platform and document diatom abundance and assemblage composition. By analyzing samples collected from a measured stratigraphic section through the basal transgression of the Upper Turonian Kanguk Formation on Devon Island, we can document changes in diatom assemblage composition that will result from changing water depths, which will provide new information about mid- Cretaceous diatom paleoecology. Two main hypotheses can be tested based on these analyses. The first being that the lower transgression of the Kanguk Formation will provide us with records of diatom appearances and disappearances that will give insight into diatom evolution. The second is that biostratigraphic correlation between the Late Turonian Devon Island, the Early Campanian Arctic Platform, and the Late Albian Weddell Sea diatoms will allow us to refine the timescale of mid-Cretaceous diatom-based biostratigraphy. To investigate these hypotheses, a series of analyses on Late Turonian samples must be completed. Because of the exploratory nature of this research, the analyses being conducted are fairly introductory and willlead to the proposal of new questions and hypotheses about the area of study.As these diatom floras are poorly known, a large component of this research project will involve description of new taxa, resolving taxonomic problems, and bringing these fossil diatom floras into a modernsystem of classification. This study will lead to the application of marine diatoms in biostratigraphic and paleoecological studies of diatom across the Arctic Platform and SverdrupBasin. As preservation of the diatom assemblages from Devon Island is excellent, this site willbecome an important reference section for future diatom studies.

IMPACT OF GREATER PRECIPITATION DURING HEAVY EVENTS ON RECHARGE AND CROP PRODUCTION IN NEBRASKA

Celeste S Kenworthy, Department of Earth and Atmospheric Sciences, University of Nebraska-Lincoln, Lincoln, NE 68588; Vaishali Sharda, Department of Biological and Agricultural Engineering, Kansas State University, Manhattan, KS 66506; Erin MK Haacker, Department of Earth and Atmospheric Sciences, University of Nebraska-Lincoln, Lincoln, NE 68588

Climate change has impacted precipitation globally and will continue to do so in the future. In the Midwest, from 1958 to 2016, there was a 29% increase in the amount of precipitation falling in the heaviest 1% of events. This trend is expected to continue. Changesin the variability of precipitation, with an increase in rainfall occurring during extreme precipitation events, may lead to changes in groundwater recharge and crop production.

Weather data from three locations across Nebraska were altered with an R script to reflect three scenarios: 16%, 29%, and 39% increases in the amount of precipitation falling in events above the 99th percentile. These scenarios were then used in a DSSAT crop model to predict changes in crop production.

Changes in groundwater recharge were calculated using a mass balance equation based on outputs from the DSSAT model. Changes in precipitation variability that may affect crop production and recharge are of great importance to the agricultural industry, which is a major contributor to Nebraska’s economy.

CONTROLS ON THE SELECTIVE REACTIVATION OF BASEMENT STRUCTURES: OBSERVATIONS FROM A BACK-ARC RIFT SYSTEM FORMED IN THE TARANAKI BASIN, OFFSHORE NEW ZEALAND

Shashank Khatri, Dr. Caroline M Burberry, Department of Earth and Atmospheric Sciences, University of Nebraska-Lincoln, Lincoln, NE 68588.

Complex reactivation of basement structures is common in basins with extended tectonic histories. Previous studies have established that pre-existing basement fabric plays a significant role in the evolution of a basin during subsequent deformation. However, the reactivation of a basin is oftentimes selective with only some of the favorably oriented structures being reactivated. The kinematics and dynamics of the interaction between the pre-existing structures,subsequent stresses and resulting deformation structures is still not well understood. The purposeof this study is to characterize and understand the evolution of a Plio-Pleistocene back-arc basinformed over a Late Cretaceous-Eocene rift, which was also inverted during the Late Eocene- Miocene.

This study uses extensive 2D and 3D seismic along with well data from the Taranaki Basin, acquired from New Zealand Petroleum and Minerals. The Taranaki Basin initiated as an intra-plate rift basin during the Late Cretaceous to Early Eocene and transformed into a foreland basin during the Late Eocene-Miocene, then became a back-arc rift basin at 5 Ma. The resulting structural framework shows selective inversion of Late Cretaceous-Eocene normal faults during Late Eocene compression which led to formation of fault propagation folds in Eocene-Miocene strata. Additionally, the Plio-Pleistocene back-arc extension is controlled by pre-existing Late Cretaceous normal faults and older basement structures through extensional reactivation and upward propagation of pre-existing faults, and by providing preferential nucleation sites for faulting.

Here we present a detailed kinematic analysis of this Plio-Pleistocene back-arc basin formed over an inverted intra-plate rift along with factors that influence its evolution. For example, mostof the displacement in the footwall of the basin-bounding Cape Egmont Fault is concentrated onnormal faults that extend from the basement to the Plio-Pleistocene strata. The conjugate Plio-Pleistocene normal faults that nucleate close to the Top Basement unconformity trend N-NNE, are significantly larger in size (~8000 m) and accumulate more displacement compared to the conjugate normal faults that nucleate in Oligocene or Miocene strata which trend more towardsthe NE, are relatively short in length (300-800 m) and accumulate low displacements. Additionally, there are Plio-Pleistocene conjugate normal faults that nucleate in Eocene or Paleocene strata but do not extend up above the Mid Miocene. The resulting back-arc deformation zone is localized and constrained by the driving extensional forces. The results fromthis study have implications for understanding how the driving forces of back-arc extension interplay with tectonic inheritance to control the evolution of a back-arc basin.

RADIOMETRIC DATING OF CANYON FILLS CONSTRAINS LATE HOLOCENEGEOMORPHIC EVOLUTION OF THE PINE RIDGE AT CHADRON, NEBRASKA

Michael B. Leite and Steve Welch, Department of Mathematical and Physical Sciences, Chadron State College, Chadron, NE, 69337

The Pine Ridge escarpment in northwestern Nebraska formed in response to incision ofthe White River and its consequent tributaries and continues to evolve in response to hydrologicinputs.

The landscape has evolved episodically, and this process has been recorded sporadicallyin the sedimentary record preserved in canyon bottoms and terraces. Several Pine Ridge streamshave their headwaters on the Chadron State College campus, where recent discovery of fossils incanyon fills offers an opportunity to constrain the timing of canyon filling and incision. The fossiliferous sediments are poorly sorted but predominantly silty colluvium. They contain a sparse fauna including a wolf (*Canis lupus*), bison (*Bison* sp.), and pond turtle. A radiometric age determined for the wolf was 745±15, and that of the bison 1550±15 radiocarbon years beforepresent. Field evidence to date indicates that these fills represent two unrelated depositional events and are not part of a longer continuous sequence. It also suggests the possibility of moreisolated data points in the study area which will need to be interpolated to tackle the complex three-dimensional puzzle of Pine Ridge history.

A SYNOPSIS OF FAVORABLE ENVIRONMENTS FOR SUPERCELL THUNDERSTORMS AND TORNADOES

Kyle Pittman, Kristen Axon, Dan Butler, Devon Healey, Matthew Wilson,
Department of Earth and Atmospheric Sciences, University of Nebraska-Lincoln,
Lincoln, NE 68588

This work provides a synthesis of the research done by the atmospheric science community on environments that are favorable for supercell thunderstorms, environments that are favorable for tornadic supercell thunderstorms, and how supercell thunderstorms modify their environment. This work also includes a review of both the historical efforts to understand these phenomena from an ingredients-based perspective, the challenges involved with properly analyzing the results of previous work on this topic, and a discussion of possible future work that can address outstanding questions. The key findings from reviewing this body of work are as follows: Given that an environment has sufficient moisture, instability, and lift for the initiation and survival of deep, moist convection, convection is most likely to organize into supercells in the presence of strong deep-layer bulk shear. This shear helps separate the storm- generated precipitation from the updraft, produces horizontal vorticity that the updraft can tilt toacquire rotation, and promotes stronger low-level storm-relative inflow which encourages broader updrafts and supercellular storm mode.

Given that a supercell exists, the storm is more likely to become tornadic in environments with strong low-level bulk shear and storm-relative helicity (SRH), high relative humidity in the low levels, and low cloud bases. Larger values of low-level SRH indicate that more streamwise vorticity is available for the storm to tilt into the vertical, encouraging stronger, steadier low-level mesocyclones which can more easily support tornadoes. Higher low-level relative humidityand lower cloud bases can suppress entrainment of dry air into the supercell and can prevent thestorm's outflow from becoming excessively cold and dense, which could be detrimental to tornado genesis.

Supercells are capable of significantly modifying their environments. Observations in the near-inflow region of supercells often show substantially higher SRH than in the far-field air mass. This may be due to the supercell's mesocyclone strengthening from dynamic feedbackscausing low- level inflow winds to accelerate into the storm, which would increase the low-levelshear and SRH while advecting in higher relative humidity air from the ambient environment. However, anvil shading and the collapse of the diurnal boundary layer may also play a role in increasing low-level shear and SRH by suppressing boundary layer mixing.

NEOGENE TO RECENT FAULT REACTIVATION IN SOUTHERN VIETNAM, IMPLICATIONS FOR MODERN DAY EXTRUSION OF INDOCHINA AND MICROBLOCK ROTATION WITHIN THE CORE OF THE SUNDALAND BLOCK

Nicholas Richard, Caroline M Burberry, Lynne J Elkins, University of Nebraska-Lincoln, Lincoln, NE 68588, USA; Le Duc Anh, Nguyen Hoang, Institute of Geological Sciences VAST, Hanoi, Vietnam

The tectonic regime of Indochina has remained controversial, in that no model has been able to adequately explain the overall tectonic framework, fault movement, and related diffuse volcanism. Secondly, it is currently unknown whether Indochina is situated within an extrusionalor extensional tectonic regime. In order to determine a tectonic model that accountsfor the Neogene diffuse volcanism, as well as contributing to solving the extrusion vs. extensiondebate, fault orientation as well as the maximum horizontal stress axes (σ_1) across the region must be known. This becomes problematic when reviewing the literature in that there are severalconflicting fault maps, which are inconsistent in fault locality, fault age, and correlation with known volcanic center. Therefore, the goals this study are to: (1) determine the age relationshipbetween fault movement and volcanic activity; (2) define the stress field by determining σ_1 at selected locations across south-central Vietnam; (3) measure the orientation of known faults; and (4) define fault motion as either dip-, strike-, or oblique-slip. The cross-cutting relationship between faults and lava flows of known volcanic ages suggest surface ruptures have taken placewithin historical times. Mineral lineations along with additional cross-cutting fault lineations onfault surfaces constrained both the age and style of faulting. These lineation sets are interpretedto represent Jurassic age dip-slip style faulting and Neogene to recent oblique-slip faulting. Ourstructural datasets of faulted surfaces throughout south-central Vietnam indicates the presence of multiple shear zones whose strikes parallel major regional faults. In addition, we observed thattheorientation of σ_1 is variable across the study area and mimics the larger (~200 km in length)adjacent faults. Therefore, these faults are inferred to be lithospheric-scale faults that bound fivedistinct tectonic blocks, which we denote as microblocks. Results here further suggest that extrusion is ongoing, and the five microblocks are not migrating as a single coherent unit withinthe core of the Sundaland Block. Instead, these blocks are jostling and rotating semi- independently of each other.

NUTRIENT INFILTRATION

Paige Vitosh, Tim Keith, Mary Keithly, Department of Chemistry, Chadron State College, Chadron, NE 69337

Agriculture is a large part of today's society, the excess amounts of nutrients in the soils indicate that we do not need to add as much fertilizer for our crop growth. Nine soil samples from two fields growing the same crops were collected to test for nitrates, phosphates,and potassium levels throughout the growing season. One field had limited exposure to additional fertilizers and the other had a plethora of fertilizers added to it. The hypothesis was that the field with less fertilizer exposure would have lower amounts of the three nutrients than the fields that had more fertilizer exposure. Soil samples were extracted using a sodium bicarbonate extraction method and analyzed for phosphate content using the Murphy-Riley analysis. To analyze for nitrates, soil samples were extracted with a potassium chloride extraction method. The amount of nitrate was determined using an ion selective nitrate probe. Soil samples were first diluted using ammonium acetate. After using an oscillator o mix the sample they were then filtered through a funnel.

Potassium levels will be determined using atomic absorption spectroscopy. As anticipated, the field that has less fertilizer had less nitrates and phosphates present in the soil when compared to the field with more fertilizer exposure. This result indicates the excess phosphates and nitrates in fertilizers were not utilized by the crops for growth and that excessive use of fertilizers may not be necessary. It would be informative to also compare field outputs to confirm this result, but that was not possible due to proprietary information that could not be released by the companies owning the fields.

ENVIRONMENTAL SCIENCES Chairperson: Mark Hammer, Wayne State College

FRIDAY, APRIL 23

MORNING SESSION - 1

8:45 ZOOM Session opens for participants to join https://wsc.zoom.us/j/93111043933

9:00 WELCOME

9:05 HYBRIDIZATION OF TURKISH *SALVIA*. Emma Raders and Bryan Drew (abstract)

9:25 A GISCIENCE ASSESSMENT OF GREEN INFRASTRUCTURE ON THE UNIVERSITY OF NEBRASKA AT KEARNEY CAMPUS. Emma Raders, Paul Burger, and Bryan Drew (abstract)

9:45 EFFECT OF ANNUAL PRECIPITATION ON LANDCOVER COMPOSITION IN THE CENTRAL REGION OF THE NEBRASKA SANDHILLS. Gabrielle Baker and Mary Ann Vinton (abstract)

10:00 **BREAK**

MORNING SESSION - 2

10:20 WATER PURIFICATION USING COST EFFECTIVE MEDIUMS. Rebecca Hiatt and Mary Keithly (abstract)

10:40 THE USE OF A HYBRID SCENARIO EXERCISE IN DROUGHT PLANNING: A COMPREHENSIVE AND HOLISTIC APPROACH FOR THE REPUBLICAN RIVER BASIN IN NEBRASKA, U.S.A. Andrew Mwape (abstract)

11:00 MINING METAGENOME-ASSEMBLED GENOMES TO QUANTIFY BACTERIAL DIMETHYLSULFONIOPROPIONATE (DMSP) SYNTHESIS POTENTIAL. Kevin Rice, Reilly Cooper, and Clay Cressler (abstract)

12:00 **LUNCH**

1:00 **BUSINESS MEETING** https://unl.zoom.us/j/97870996278
Nebraska Academy of Sciences (all members)
State of the Academy
Awards Ceremony
Vote by NAS members on Revisions to NAS Constitution
Comments from Members-at-Large

1:30-2:30 **MAIBEN LECTURE** https://unl.zoom.us/j/9289316099
Dennis Ferraro, *Reflections of a Nebraska Herpetologist*

ENVIRONMENTAL SCIENCES ABSTRACTS

EFFECT OF ANNUAL PRECIPITATION ON LANDCOVER COMPOSITION IN THECENTRAL REGION OF THE NEBRASKA SANDHILLS

Gabrielle Baker, Department of Environmental Science, Creighton University, Omaha, NE 68178, Mary Ann Vinton, Department of Biology, Creighton University, Omaha, NE 68178

My project concerns land cover and surface water in the Nebraska Sandhills, the major recharge area for one of the world's largest groundwater sources, the High Plains (Ogallala) Aquifer. The Sandhills region is one of North America's most intact prairie ecosystems and 95%of land use consists of low intensity cattle grazing. Water is a key resource for growing hay foragein this semi-arid grassland. Ranchers rely on either naturally occurring wet meadows or centerpivot irrigation systems (CPIS) to produce hay. This project's focus was on the comparison of wet meadow and CPIS in two Nebraska counties, Grant and Hooker, in wet versus dry periods.

These counties were chosen because they are in the central Sandhills, are adjacent, and are similar in size yet differ in the amount of naturally occurring, ground water-fed meadows. I used ArcGIS and the USDA's Cropland Data Layer (known as "CropScape"), an annual satellite imagery-derived land cover map to quantify cover of wet meadows and the number of CPIS. I compared these counties from 2002 to 2019, spanning wet and dry years. Precipitation and drought indices data were gathered from PRISM Climate Group. This analysis has shown that different Sandhill counties have contrasting water resources, with an abundance of naturally occurring wet meadows in Grant County, whereas Hooker County relies more on CPIS. Furthermore, my analysis suggests that the landscape changes during drought years, witha decline in wet meadows, an increase in barren ground and an increase in reliance on center pivot irrigation and other irrigated systems for crops. These two counties exhibit the breadth of strategies that ranchers must use for water resources. In a changing climate, with potentially more extremes in precipitation, such diversity of strategies will likely be important. Overall, this research will contribute to a better understanding of the sustainability of land use and the future of groundwater resources in the Nebraska Sandhills.

WATER PURIFICATION USING COST EFFECTIVE MEDIUMS

Rebecca Hiatt, Mary Keithly, Department of Chemistry, Chadron State College, Chadron, NE 68337

Having access to clean drinking water is necessary to sustain life. To provide clean drinking water to people, a cost-effective water purification system is necessary. This study compared the ability of cost-effective mediums to maintain a pH level that is safe to drink, remove bacteria from rainwater, and maintain a safe drinking level of phosphates. The ability topurify water was tested for four mediums: crushed brick, sand, charcoal, and clay. Three differentwater sources were examined and underwent the purification process in which the water was placed with the medium and stirred for one hour. The water samples included: tap water from Chadron, Nebraska; Briggs Pond located in Chadron, Nebraska; and a dirty water standard sample that was made in the lab. Each sample underwent testing for coliforms, bacteria, phosphate level, and pH level before and after the purification process. The coliforms and bacteria testing utilized 5 mL of water plated on agar slants and incubated for 24 hours. The pHof each water sample was tested

using a pH meter. When crushed brick was used as a medium, the resulting purified water displayed an increase in phosphate levels and a slight decrease in the volume of water recovered. Sand, as a medium, resulted in purified water that was slightly more acidic than the original sample, but all other tests remained consistent with the original sample and yielded the highest amount of water after the purification process. Purification utilizing charcoal as a medium resulted in water with a significantly lower pH and a 73% loss of the original volume of water. When clay was used as a medium, there was approximately 29% water loss during purified water, and the purified water was significantly more acidic thanthe original sample. Microbes were present in the original water sample from Briggs Pond and the dirty water standard, but not in any purified water sample from any medium. Accessing cleandrinking water is necessary to sustain life, although not all people have access to clean drinkingwater. Charcoal is not a cost-effective medium for water purification as it does not yield much water after purification, and the water becomes significantly more acidic. Looking at the four different mediums for purification, sand would be the most cost-effective method to purify wateras it demonstrated the ability to lower the pH of the water and produced the highest yield of water.

THE USE OF A HYBRID SCENARIO EXERCISE IN DROUGHT PLANNING: A COMPREHENSIVE AND HOLISTIC APPROACH FOR THE REPUBLICAN RIVER BASIN IN NEBRASKA, USA

Andrew Mwape, Department of Natural Resources, University of Nebraska-Lincoln, Lincoln, NE 68583-0961

Drought planning research has proliferated in parallel with concerns about how different communities can successfully implement drought plans and effectively equip themselves to bounce back in the face of drought events. Unlike the conventional way of planning and implementing drought plans, the use of scenario-based exercises engages communities affectedby drought to plan and implement their own strategies and actions of adaptation during drought.The aim of this project is to come up with a comprehensive drought plan for the Republican River Basin in Nebraska. The project is using a hybrid of the Tabletop and Workshop scenario-based approaches, and builds on the already existing basin-wide plans and the respective droughtplans for the Natural Resource Districts in the Republican River Basin. This being the first timethat a hybrid of scenario-based exercise is being used, the project is bringing together communities affected by drought in the river basin and engaging them to ensure viability of theplan and success of the project. With this approach, the project seeks to educate and enhance community knowledge on drought impacts and promote a communal and co-operative approach to minimizing drought impacts in the Republican River Basin.

HYBRIDIZATION OF TURKISH *SALVIA*

Emma Raders, Bryan Drew, Department of Biology, University of Nebraska at Kearney, Kearney, NE 68845

There are about 1,000 species of *Salvia* distributed around the world. In Turkey, one ofthe most species rich areas of *Salvia*, this has led to hybridization between some species of *Salvia*. Here, we investigate two specific instances of putative hybridization between species of*Salvia* in Turkey, neither of which has previously been documented. For this project, we used PCR amplification of selected chloroplast and nuclear DNA markers and resultant phylogenetictrees to

assess potential hybridization events. Two putative hybrid instances were examined, oneinvolving *Salvia aucheri* subsp. *canescens* and *Salvia heldreichiana*, and another involving *Salviavermifolia* and *Salvia cyanescens*. These putative hybrids do not resemble any other described species, but have morphological features in common with their respective hypothesized parentalspecies. Using phylogenetic and morphological evidence, we document two instances of hybridization between species of *Salvia* in Turkey and provide formal names for these hybrid taxa: *Salvia* × *karamanensis* (*S. aucheri* subsp. *canescens* × *S. heldreichiana*) and *Salvia* × *doganii* (*S. cyanescens* × *S. vermifolia*).

A GISCIENCE ASSESSMENT OF GREEN INFRASTRUCTURE ON THE UNIVERSITY OF NEBRASKA AT KEARNEY CAMPUS

Emma Raders, Department of Biology, University of Nebraska at Kearney, Kearney, NE 68845, Paul Burger, Department of Geography, University of Nebraska at Kearney, Kearney, NE 68845, Bryan Drew, Department of Biology University of Nebraska at Kearney, Kearney, NE 68845

Green infrastructure has become a popular area of study and a favored framework for conservation and establishing ecosystem services. Green infrastructure is defined using vegetation, soil, or other natural elements to create a healthier longer lasting urban area. Incorporation of green infrastructure in urban planning has been found to promote the longevityof different structures including buildings and sidewalks. This study examines the use of tree locations across the University of Nebraska at Kearney (UNK) campus as green infrastructure to manage existing trees, find optimal locations for new trees, and safeguard campus infrastructure. Spatial database layers for UNK are created in ArcGIS including buildings, sidewalks and roads. Tree locations are collected using a Garmin Rino 755t converted to an ArcGIS feature class and attributed. Trees and buildings are buffered 15, 20 and 25 feet based upon the average tree canopy sizes for small medium and large trees. Sidewalks are buffered by 15 feet and the resulting buffer layers and central campus region are overlaid to produce areas where tree encroachment is occurring on existing infrastructure and campus locations that could support higher tree density. The results of this study will be of interest to urban planners and conservationists in ecosystem development.

MINING METAGENOME-ASSEMBLED GENOMES TO QUANTIFY BACTERIAL DIMETHYLSULFONIOPROPIONATE (DMSP) SYNTHESIS POTENTIAL

Kevin Rice, Reilly Cooper, Clay Cressler, Department of Ecology and Evolution, University of Nebraska-Lincoln, Lincoln, NE 68505

The organosulfur compound dimethylsulfoniopropionate (DMSP) is the main precursorto dimethylsulfide (DMS), a molecule that contributes significantly to Earth's sulfur cycle and climate regulation. While pathways for DMSP biosynthesis have been well-described in plants and cyanobacteria, only recently have bacterial DMSP pathways been described. In some α-Proteobacteria, a DMSP pathway consisting of four key enzymes (DMSPAAT, DMSPADH, MSMT and SMMDC) has been characterized. However, it is unknown how widespread this specific DMSP biosynthesis pathway is among bacteria and environments. To address this, we mined a set of 52,515 published metagenome-assembled bacterial genomes (MAGs) using custom-built profile HMMs of the genes involved in this pathway. Our results indicate that many

more bacteria than the previously described α-Proteobacteria, particularly aquatic species, encode for DMSP biosynthesis. We identified 251 unique bacterial MAGs with all four enzymes.Within these MAGs, the copy number of each gene in the biosynthetic pathway varied across environments, with aquatic bacteria having significantly higher DMSPAAT-encoding genes than others. However, the copy number for MSMT did not vary significantly, with MAGs having at most two copies, potentially suggesting a more conserved function compared to the other pathway genes. Our findings indicate that DMSP biosynthetic potential is a rare bacterialfunction but can be found readily in some aquatic bacteria, particularly in *Actinobacteriota* and *Bacteroidota*. This work can serve as a basis for future targeted inquiries into bacterial DMSP biosynthesis in aquatic ecosystems.

GENERAL CHEMISTRY Chairperson: Joshua Darr, University of Nebraska at Omaha

FRIDAY, APRIL 23

MORNING SESSION – 1

7:45 Zoom Session opens for participants to join https://unomaha.zoom.us/j/97599798443

8:00 WELCOME

8:05 INSIGHT INTO THE SURFACE EFFECT OF MICA ON THE GROWTH OF XENON HYDRATE FILMS AT SUB-ZERO TEMPERATURES. Avinash Kumar Both and Chin Li Cheung (abstract)

8:25 SYNTHESIS AND EVALUATION OF DIARYLDICARBOXY CYCLOBUTANE LIGANDS FOR ANTICANCER EFFECTS. Wuilian Martinez and Mahesh Pattabiraman (abstract)

8:45 AFFECTING PHOTOCHEMICAL SINGLET OXYGEN GENERATION USING SUPRAMOLECULAR CHEMISTRY. Bailey Premer, Rishav Srivastava, and Mahesh Pattabiraman (abstract)

9:05 CHARACTERIZATION OF DRUG-HUMIC ACID INTERACTIONS BY HIGH-PERFORMANCE AFFINITY CHROMATOGRAPHY. Sazia Iftekhar, Saumen Poddar, Rebecca Ringer, and David S. Hage (abstract)

9:25 COMPARISON OF MOBILEPHONE AND CCD CAMERAS FOR DETECTION OF BIOGENIC AMINES VIA RUTHENIUM COMPLEX ELECTROGENERATED CHEMILUMINESCENCE. Erin M. Gross, Nicolas Heckenlaible, Alyssa Kava, and Charles S. Henry (abstract)

9:45 SYNTHESIS OF HALOKETOSES FOR PREPARATION OF PERDURABLE MOSQUITO REPELLENTS. Becca Boen, Martin Hulce, Kaitlin Nagamine, and Karolina Rooney (abstract)

10:00 **BREAK**

MORNING SESSION – 2

10:20 STRUCTURAL ANALYSIS OF HUMAN OAZ1-PK RNA. Diego Gomez, Rhiannon McCracken, Spencer Thompson, Siddharth Venkatraman, and Juliane Soukup (abstract)

10:40 ERIA NANOPARTICLES: SYNTHESIS AND APPLICATION FOR PLASMA CATALYSIS. Deepa Choudhry (abstract)

11:00 AN ENGINEERED BIOSENSOR FOR THE HERBICIDE DICAMBA. Chase M. McCollum, Abbie M. Manse, and Benjamin M. Brandsen (abstract)

11:20 RAPID FLUOROMETRIC SANDWICH ASSAY FOR DETECTION OF COVID-19 ANTIBODIES. Ashley G. Woolfork, Saumen Poddar, Kyungah Suh, Sazia Iftekhar, Susan Ovbude, Sadia Sharmeen, Jacob Jones, Isaac Kyei, and David S. Hage, and Katelyn Dial (abstract)

11:40 ANALYSIS OF THE METABOLIC EFFECTS OF DIABETES ON THE FUNCTION AND STRUCTURE OF GLYOXAL AND METHYLGLYOXAL-MODIFIED HUMAN SERUM ALBUMIN. Susan Ovbude, Pingyang Taoand, and David S. Hage (abstract)

11:55 **CHEMISTRY SECTION MEETING**

12:00 **LUNCH**

1:00 **BUSINESS MEETING** https://unl.zoom.us/j/97870996278
Nebraska Academy of Sciences (all members)
State of the Academy
Awards Ceremony
Vote by NAS members on Revisions to NAS Constitution
Comments from Members-at-Large

1:30-2:30 **MAIBEN LECTURE** https://unl.zoom.us/j/9289316099
Dennis Ferraro, *Reflections of a Nebraska Herpetologist*

INSIGHT INTO THE SURFACE EFFECT OF MICA ON THE GROWTH OF XENONHYDRATE FILMS AT SUB-ZERO TEMPERATURES

Avinash Kumar Both and Chin Li Cheung, Department of Chemistry, University of Nebraska-Lincoln, Lincoln, NE 68588

Gas hydrates are encapsulation-type of compounds composed of hydrogen bonded water cages with guest gas molecules trapped within these cages. Gas hydrates have been explored for their diverse applications in carbon sequestration, natural gas storage and transport, gas separation and water desalination. In this talk, we aim to provide mechanistic insight into the growth process of xenon hydrate film on mica through *in situ* optical microscopic analysis. Xenon was chosen as it has emerged as an attractive hydrate former for studying various aspects of hydrate growth dynamics as it chemically inert and has the ability to form hydrate at relatively less severe conditions (1.5 bar and 272 K) in comparison to other gases such as CH_4 and CO_2 which require extremely high pressure (~200 bar) to form hydrates. The major objective of this research study was to provide insight into xenon hydrate film growth dynamics at the xenon– water interface in the presence of a substrate surface and determine the growth rate response to perturbations in the temperature driving force. Mica (sheet silicate or phylosilicate) was chosen as a model silicate surface in our study as silicate minerals are ubiquitously spread across the whole universe in various forms. To our best knowledge, the growth of xenon hydrate film on mica has not been studied before. The orientation and properties of water molecules near a surface are quite distinct from those in the bulk state. The geometric constraint by the solid surfaces and attractive/repulsive interactions between a substrate surface and water molecules change the orientation of water molecules. Mica (sheet silicate) was chosen as a model silicate surface to evaluate the xenon hydrate film growth on a substrate surface. Visual investigation through optical microscopy was used to determine the growth rates of xenon hydrate films on mica at sub-zero temperatures. Under the studied experimental conditions, xenon hydrate films were observed to form at a rapid rate of ~200 µm/sec in comparison to those of other gas hydrates which usually take hours to form. Mass transfer studies were also carried out by examining the net mass flux and aqueous solubility of xenon. Both the growth rate analysis and mass transfer studies demonstrated that the mica surface assisted the growth process of xenon hydrate films when the mass flux of xenon was relatively low at lower degree of sub-cooling. Our findings showed that the mica surface aided the growth process of xenon hydrates.

CERIA NANOPARTICLES: SYNTHESIS AND APPLICATION FOR PLASMA CATALYSIS

Deepa Choudhry, Department of Chemistry, University of Nebraska-Lincoln, Lincoln, NE 68588

Nano structured Cerium (IV) oxide (CeO_x: x = 1.5 to 2), also known as nanoceria is a basic oxide exhibits as cubic fluorite structure. It has unique catalytic properties because of its ability to interchangeability exist in Ce^{3+}/Ce^{4+} oxidation state and has high surface area to volume ratio with a greater amount of oxygen vacancy defects when compared to bulk. There are many synthetic routes involving sol-gel method, hydrothermal method microwave synthesis has been reported for the production of ceria, but they are expensive, time consuming or require elevated temperature or

pressure. Recently, we reported the synthesis of ceria nanoparticles with 2-to-5 nm diameters by directly bubbling ozone through alcohol solutions of cerium (III) salts with reaction yield ca. 10%.We found out; we can increase the reaction yield over 90% by controllingthe acidity of the reaction mixture with acetate with the direct ozonation method. Our research showing the effects of this methodology on the physical characteristics of the NPs through thorough characterization of the produced nanoparticles, the effect of increasing lithium acetateto cerium nitrate ratios was explored to demonstrate the relationships between product yield, acetate concentration, crystallinity, and size distribution of nanoparticles. For further studies, Ceria can be doped with other elements (like Ru, Ni, Cu, Zn) since ionic radius of these dopantsare comparable to Ce^{3+}/Ce^{4+} ionic states and due to its ability to exist in Ce^{3+}/Ce^{4+} states. In recent years, studies onthe CO_2 hydrogenation to methanol has gained considerable attention. Despite, a well-developed process for CO_2 hydrogenation to methanol, the use of CO2 as feedstock for methanol remains a challenge as CO_2 is kinetically and thermodynamically inert and requires high temperature and pressure. For addressing this difficulty, our aim is to design a plasma reactor and study the effect of doped ceria towards methanol production. A non-thermalplasma catalytic synthesis is emerging as an efficient alternative to the conventional methanol synthesis since it can be used at atmospheric pressure and room temperature. High voltage willbe applied to generate plasma usinga mixture of CO_2 and H_2 gas to synthesize methanol.

STRUCTURAL ANALYSIS OF HUMAN OAZ1-PK RNA

Diego Gomez, Rhiannon McCracken, Spencer Thompson, Siddharth Venkatraman, Juliane Soukup, Department of Chemistry, Creighton University, Omaha, NE 68178

Riboswitches are segments of noncoding RNA that bind to products of cellular metabolism in order to regulate the expression of downstream genes. Upon binding to a metabolite, riboswitches undergo a conformational change that modulates the expression of genes involved in the synthesis of the cognate metabolite, thereby providing a mechanism of feedback regulation fora particular biosynthetic pathway. This form of genetic regulation has been widely studied in bacteria, but no riboswitches have been identified in animals. The Soukuplab is investigating a potential riboswitch involved in the biosynthesis of polyamines, small organic molecules that play a role in cell growth and differentiation and are frequently upregulated in cancer cells. Polyamine synthesis is dependent on the ornithine decarboxylase enzyme (ODC), which is negatively regulated by ornithine decarboxylase antizyme (OAZ). Theexpression of antizyme protein is regulated by polyamine-enhanced translational frameshiftingof the OAZ mRNA. Specifically, a pseudoknot (PK) in the mammalian OAZ RNA may play a role in this frameshifting. Previous work in the lab strongly suggests the presence of a riboswitch in the mouse OAZ RNA by demonstrating specificity of polyamine binding as well as polyamine-induced conformational changes. In order to determine the presence of a riboswitchin humans, equilibrium dialysis was used to examine the specificity of polyamine binding to human OAZ-PK RNA. Preliminary data suggests specific binding of the polyamine spermine. Additional experiments using In-line probing have investigated polyamine-induced conformational changes. Preliminary data suggests concentration-dependent conformational changes induced by spermine. Future studies will use Selective 2'-Hydroxyl Acylation analyzedby Primer Extension (SHAPE) to further investigate polyamine-induced conformational changes. The ability to target riboswitches and regulate metabolic pathways, such as polyamine synthesis, could lead to the development of novel

antibiological and anticancer therapeutics.

COMPARISON OF MOBILE PHONE AND CCD CAMERAS FOR DETECTION OFBIOGENIC AMINES VIA RUTHENIUM COMPLEX ELECTROGENERATED CHEMILUMINESCENCE

Erin M. Gross, Nicolas Heckenlaible, Department of Chemistry, Creighton University, Omaha, NE 68178, Alyssa Kava, Charles S. Henry, Department of Chemistry, Colorado State University, Fort Collins, NE 80524

Portable analytical devices are important to the development of point-of-care diagnostics and on-site safety testing. Electrogenerated chemiluminescence (ECL) is an analytical technique that combines features of both electrochemical and luminescence methods. It possesses electrochemical advantages such as ease of miniaturization and portability, along with the sensitivities of fluorescence methods. In this work, the ECL reaction between tris(2,2'- bipyridyl) ruthenium(II) and biogenic amines was used to develop a detection method for biogenicamines at screen-printed carbon ink electrodes. Both a mobile phone camera and CCDcamera were used as the detectors. Each detector was aligned with the electrodes via 3D printedlight-tight housings. Image analysis was performed using the free software ImageJ. The analytical figures of merit of the two methods were compared. The mobile phone's optical sensorachieved limits of detection of 127, 195, and 421-μM for spermidine, putrescine, and histamine,respectively. Thes edetection limits were slightly higher than that determined for the CCD, but were acceptable for applications to food safety. The mobile phone was able to determine the content of amines in skim milk to within an 8.6% error.

SYNTHESIS OF HALOKETOSES FOR PREPARATION OF PERDURABLE MOSQUITO REPELLENTS

Becca Boen**,** Martin Hulce, Kaitlin Nagamine**,** Karolina Rooney, Department of Chemistry and Biochemistry, Creighton University, Omaha, NE 68178

Mosquitoes transmit diseases affecting millions of people worldwide. These diseases include malaria, dengue fever, filariasis, yellow fever, Zika fever, West Nile virus, and various encephalitides. Control of these diseases relies on mosquito population reduction using insecticides and larvicides, and on area and personal mosquito repellents. These latter repellents must be applied before mosquito exposure and regularly thereafter, as their effectiveness declines with time. Perdurable mosquito repellents may be accessible by attaching known topicalrepellents to skin-binding sugars by means of hydroyzable linker groups. To this end, synthesisof a set of haloketose and *N*,*N*-dimethylaminoethyloxyketose skin-binding sugars was investigated. The simplest haloketose, 1-bromo-3-hydroxy-2-propanone, was found to rapid decompose when chemically pure: Protected 1-bromo-3-(*t*-butyldiphenylsilyloxy)-2-propanonewas investigated as an alternative, as was the similar 1-bromo-3,4-acetonide of L-erythrulose. Finally, etherification of 2,5-diethoxy-2,5-bis (hydroxymethyl)1,4-dioxane using (2- chloroethyl) dimethylamine was studied as a route to 1-hydroxy-3-(*N*,*N*- dimethylaminoethyloxy)-2-propanone.

CHARACTERIZATION OF DRUG-HUMIC ACID INTERACTIONS BY HIGH-PERFORMANCE AFFINITY CHROMATOGRAPHY

Sazia Iftekhar, Saumen Poddar, Rebecca Ringer, and David S. Hage, Department of Chemistry, University of Nebraska-Lincoln, Lincoln, NE 68588

The association of drugs with dissolved organic matter such as humic acid can help in understanding the transportation and bioavailability of drugs in environmental water. This study focuses on developing a high-performance affinity chromatography (HPAC) method based on flow-through humic acid columns to characterize the binding of humic acid with drugs such as tetracycline, carbamazepine, ciprofloxacin, and norfloxacin. The stationary phase was preparedby entrapping commercial humic acid on diol-bonded silica support containing dihydrazide groups on its surface, in presence of mildly oxidized glycogen. A pH 7.4 potassium phosphate buffer was employed as the application and elution buffer, and a temperature of 25 ℃ was used for all the chromatographic studies to mimic the binding conditions for the systems under investigation. The interaction between humic acid and the drugs was studied using zonal elutionby injecting a small amount of drug onto the humic acid column and monitoring the retention time of the drug inside the column using an on-line absorbance detector. The association equilibrium constant, K_a, for thedrug-humic acid interactions were found to be in the range of 10^3 to 10^5 M^{-1}. The information obtained from this study can be useful in monitoring and managing drugs that interact with humic acid when circulated in environmental water.

AN ENGINEERED BIOSENSOR FOR THE HERBICIDE DICAMBA

Chase M. McCollum, Abbie M. Manse, Benjamin M. Brandsen, Departmentof Chemistry and Biochemistry, Creighton University, Omaha, NE 68178

Herbicides have been commercially used for many years, enabling development of herbicide-resistant crops that lead to increased crop yields. It has recently been observed, however, that the herbicide dicamba can drift into nearby fields where it was not applied, damaging crops and contaminating water sources. Technology to sense dicamba would enable rapid and continuous monitoring for this pollutant. Microorganisms have been increasingly used to detect specific chemicals in their environment through engineered proteins that activate expression of a reporter gene in the presence of an inducer chemical. The bacterial AraC proteinregulates transcription of genes that catalyze arabinose catabolism, responding to environmental arabinose conditions. Others have identified mutations in the *E. coli* AraC protein that allow it to respond to additional inducer compounds, including several benzoic acid derivatives relatedto dicamba. Using directed evolution, we have identified several AraC variants that activate expression of a fluorescent reporter gene in the presence of dicamba. One of these variants, AraC-1A9, shows a four-fold increase in reporter gene expression in the presence of 5 mM dicamba compared to without dicamba. We are currently improving AraC-1A9's response to dicamba through additional rounds of directed evolution, and we are developing a cell-free transcription and translation assay to add sensitivity and flexibility when using the AraC-1A9 biosensor to detect dicamba.

ANALYSIS OF THE METABOLIC EFFECTS OF DIABETES ON THE FUNCTION AND STRUCTURE OF GLYOXAL AND METHYLGLYOXAL-MODIFIED HUMAN SERUM ALBUMIN

Susan Ovbude, Pingyang Tao and David S. Hage, Department ofChemistry, University of Nebraska-Lincoln, Lincoln, NE 68588

During diabetes, human serum albumin (HSA) is modified by reactive dicarbonyl compounds such as methylglyoxal (MGO) and glyoxal (GO). These compounds react with the lysine and arginine residues on HSA (an important drug-carrying agent) to form advanced glycation end-products (AGEs), which have been implicated in diabetes and its complications. This study characterized the metabolic effects of diabetes on the structure and function of HSA. High-performance affinity chromatography (HPAC) was used to investigate the changes in binding that occur with specific drugs with MGO and GO-modified HSA. Zonal elution studies were carried out with repaglinide (a drug used to treat type II diabetes) on columns that contained HSA or modified HSA prepared *in vitro*. *R*-Warfarin and L-tryptophan were used in these studies as site-selective probes for Sudlow sites I and II of HSA (the major drug-binding sites onthis protein. The structural alterations in HSA caused by the different levels of MGO and GO were evaluated by using a high-resolution matrix-assisted laser desorption/ionization Fourier- transform ion-cyclotron resonance mass spectrometer. The differences in the function andstructure of HAS at different levels of MGO and GO modification for HSA were compared. Thisinformation should provide a better understanding of the metabolic effects of diabetes on drug binding with HSA and the effects of glycation-related changes on this protein, as can be used inthe future to develop improved treatments for diabetes patients.

SYNTHESIS AND EVALUATION OF DIARYLDICARBOXY CYCLOBUTANE LIGANDS FOR ANTI-CANCER EFFECTS

Wuilian Martinez, Mahesh Pattabiraman, Department of Chemistry, University of Nebraska at Kearney, Kearney, NE 68845

The diaryldicarboxy cyclobutene (DAC) structural core is found in many natural compounds and its stereoisomers are referred to as truxillic or truxinic acid in phytochemical nomenclature. These cores are found in ligand structures of adenosine receptors (ARs: A_1, A_{2A}, A_{2B}, A_3) and fatty acid binding proteins (FABPs) both of which are involved in cancer proliferation. ARs are known to be up/downregulated, depending on the subtype, in cancer types such as colorectal and breast cancer, while FABP is upregulated in metastatic prostate cancer. Due to this AR and FABP ligands are pursued for their promise in anti-cancer drug discovery research. Our group is involved in synthesis and cellular assays of truxillic and truxinic acid ligands for ARs. The DAC core contains at least four stereogenic centers which could produce up sixteen isomers. Thus, the stereo- and regiospecific synthesis of AR ligands is challenging. Our group is involved in using supramolecular approach to controlling the relative spatial orientation of reactants to achieve selectivity in chemical transformations. We have utilized thisapproach to synthesize AR and FABP ligands using classical organic transformations and photochemical reactions. The synthesized ligands are also tested for their anti-cancer effects incellular models.

AFFECTING PHOTOCHEMICAL SINGLET OXYGEN GENERATION USING SUPRAMOLECULAR CHEMISTRY

Bailey Premer, Rishav Srivastava, and Pattabiraman Mahesh, Department of Chemistry, University of Nebraska at Kearney, Kearney, NE 68845

Singlet oxygen ($^1O_2$) is the excited state electronic isomer and a reactive form of molecular oxygen, which is most efficiently produced through dye sensitization of ambient triplet oxygen. Photochemical singlet oxygen generation (*SOG*) has received tremendousattention historically, both for its practical application as well as its physicochemical interactions with matter. Such advancements were achieved through design factors focused predominantly on the dye molecule, whose self-directed photoactivity is relegated to self-regulated structure and energetics in ground and excited states. The *SOG* efficiency of a photosensitizer is often limited by structural, intermolecular, and electronic factors. In the recent past we have been engaged in exploring supramolecular approaches to overcoming aforementioned limitations. This talk will present our preliminary findings on the influence of macrocyclic cavitands on *SOG* efficiency of some dyes. Based on the initial analysis, we hypothesize the host-guest interactions that might be responsible for the observed effects and the future direction of our project.

RAPID FLUOROMETRIC SANDWICH ASSAY FOR DETECTION OF COVID-19 ANTIBODIES

Ashley G. Woolfork, Saumen Poddar, Kyungah Suh, Sazia Iftekhar, Susan Ovbude, Sadia Sharmeen, Jacob Jones, Isaac Kyei, and David S. Hage, Department of Chemistry, University of Nebraska-Lincoln, Lincoln, NE 68588-0304; Katelyn Dial, ni2o, Inc., Providence, RI 02906

SARS-CoV-2, better known as COVID-19, is a highly transmitted disease that appearedin late 2019 and led to a global pandemic by March 2020. As the number of cases began to rise, severe illness, and high death tolls have followed. In this study, an assay for antibodies was developed for the rapid detection of COVID-19 using silica-coated magnetic particles that contained a recombinant antigen from SARS-CoV-2 and secondary antibodies containing fluorescent labels. Human serum albumin (HSA), antibodies against HSA, and fluorescein labeled secondary antibodies were used as an initial model system. The final method used a recombinant form of spike protein S1 from SARS-CoV-2 as the immobilized target agent, as well as secondary antibodies that contained fluorescent tags based on Alexa Fluor dyes. The response of this method was characterized and optimized, allowing detection of antibodies to theimmobilized antigen at levels in the low nM range and with total incubation times of only 5 min.This method was found to be selective for antibodies against SARS-CoV-2 when compared to antibodies against other infectious agents such as the Middle Eastern respiratory virus (MERS) and anti-respiratory synthetical virus (RSV). This assay is currently being adapted for use in a portable device for the rapid detection of COVID-19 antibodies. The same general assay schemecan also be modified for the detection of antibodies against other infectious agents or viral antigens.

GENERAL PHYSICS Chairperson: Adam Davis, Wayne State College

FRIDAY, APRIL 23

MORNING SESSION - 1

7:45 ZOOM Session opens for participants to join https://wsc.zoom.us/j/95312777261

8:00 WELCOME

8:05 IMPLEMENTING QUANTUM GATES WITH LENGTH-3 DYNAMIC GRAPHS. Ibukunoluwa Adisa, Tom Wong (abstract)

8:25 OFTWARE UPGRADES FOR THE STAR GATING GRID AT BROOKHAVEN NATIONAL LABORATORY. Emma Dufresne (abstract)

8:45 PHOTOPRODUCTION OF RHO MESONS IN ULTRA-PERIPHERAL D-AU COLLISIONS AT RHIC. Solon Fernandes and Dr Janet Seger (abstract)

9:05 IMPLEMENTING GLUCOSE-DERIVED CARBON NANODOTS IN DYE-SENSITIZED SOLAR CELLS TO IMPROVE EFFICIENCY. Max Markuson DiPrince, Harsh Uppala, Dave Sidebottom, and Andrew Baruth (abstract)

9:25 DESIGN OF KINETIC TILE THROUGH THE APPLICATION OF PIEZOELECTRIC ENERGY HARVESTING. Caleb Osmond (abstract)

9:45 **ρρρρ′** PHOTOPRODUCTION IN ULTRA-PERIPHERAL HEAVY ION COLLISIONS WITH THE ALICE DETECTOR. G.A. Shani Nimeshika Perera (abstract)

10:00 **BREAK**

MORNING SESSION - 2

10:20 MATHEMATICAL MODELLING OF IMPEDANCE-BASED CELL MIGRATIONFOR PHYSICS OF CANCER.Shani Melanie Schwengler,Andrew Walther,Michael Mimlitz, Harry Kramer, Jack Lewison, Megha Jacob, Joe Bamesberger, and Andrew Ekpenyong (abstract)

10:40 PHOTONUCLEAR PRODUCTION OF THE PHI MESON IN ULTRA-PERIPHERAL COLLISIONS AT STAR. Johnny Zigmond (abstract)

12:00 **LUNCH**

1:00 **BUSINESS MEETING** https://unl.zoom.us/j/97870996278
Nebraska Academy of Sciences (all members)
State of the Academy
Awards Ceremony
Vote by NAS members on Revisions to NAS Constitution
Comments from Members-at-Large

1:30-2:30 **MAIBEN LECTURE** https://unl.zoom.us/j/9289316099

Dennis Ferraro, *Reflections of a Nebraska Herpetologist*

GENERAL PHYSICS ABSTRACTS

IMPLEMENTING QUANTUM GATES WITH LENGTH-3 DYNAMIC GRAPHS

Ibukunoluwa Adisa, Tom Wong, Department of Physics, Creighton University, Omaha, NE 68178

The continuous-time quantum walk is a quantum version of a random walk that evolves by Schroedinger's equation. With the Hamiltonian equal to the adjacency matrix of a sequence of graphs, called a dynamic graph, continuous-time quantum walks have been shown to implement quantum gates, including the *T* gate, Hadamard *H* gate, and the Controlled–NOT (CX) gate. Since these gates make up a universal set of quantum gates, they can implement any other arbitrary quantum gate up to an arbitrary approximation. This process, however, can be tedious and inefficient. To alleviate this, we have developed a parameterized dynamic graph on which a continuous-time quantum walk can implement any arbitrary single-qubit quantum gate, and we have also extended this result to implement any two-qubit controlled-unitary quantum gate. These dynamic graphs have at most length three. Using these, we implemented Draper's quantum addition circuit, which is based on the quantum Fourier transform, using a continuous-time quantum walk on a dynamic graph.

SOFTWARE UPGRADES FOR THE STAR GATING GRID AT BROOKHAVEN NATIONAL LABORATORY

Emma Dufresne, Department of Physics, Creighton University, Omaha, NE 68102

STAR (Solenoidal Tracker at RHIC), the high-energy physics experiment located at Brookhaven National Laboratory (BNL), analyzes collisions of heavy ions traveling at relativistic speeds using various detectors. These detectors track the trajectory, measure the energy, and determine the particle type for thousands of particles created in each collision. For safety reasons, remote computers are programmed to continuously retrieve the operation statusof these detectors. These remote computers make up a controls system, powered by Experimental Physics and Industrial Control System (EPICS). One of the largest and most important sub-detectors at STAR is the Time Projection Chamber (TPC). Its purpose is to trackparticle trajectory after collisions. One component of the Time Projection Chamber, called the Gating Grid, is located at either endcap of the TPC to control the flow of charged particles. TheGating Grid's operating voltages are controlled and monitored by an Input and Output Control (IOC) system. The existing IOC required an update from unsupported software to Python. The IOC has been written and the next step is to test its performance.

PHOTOPRODUCTION OF RHO MESONS IN ULTRA-PERIPHERAL D-AU COLLISIONS AT RHIC

Solon Fernandes, Dr Janet Seger, Department of Physics, Creighton University, Omaha, NE 68178

The rho meson is copiously produced in collisions taking place at various colliders. Ultra-peripheral collisions are of particular interest because hadronic interactions are suppressed and photoproduction can be observed on a significant scale. This work analyzes the deuterium-gold

ultra-peripheral collision data collected during the 2016 run at the Relativistic Heavy Ion Collider (RHIC) to determine the cross-section for the photoproduction of the neutral rho meson. While the rho meson decays very quickly, it can be identified from the ionization tracks left by its daughter particles – two charged pions. This talk will focus on the method of analysisof this data, which involves mining the data for events that produce the rho meson.

IMPLEMENTING GLUCOSE-DERIVED CARBON NANODOTS IN DYE-SENSITIZED SOLAR CELLS TO IMPROVE EFFICIENCY

Max Markuson DiPrince, Harsh Uppala, Dave Sidebottom, Andrew Baruth,
Department of Physics, Creighton University, Omaha, NE 68178, Eric Marsh,
Joel Destino, Department of Chemistry, Creighton University, Omaha, NE 68178

Dye sensitized solar cells offer a low-cost, scalable approach to photovoltaics with earth-abundant constituents, but have traditionally been poor at ultraviolet absorption. We introduce a cheap, facile method to incorporate fluorescent carbon nanodots from hydrothermal degradation of glucose solutions to enhance efficiency in the ultraviolet. Although carbon nanodot isolation has been a consistent challenge due to the presence of molecular byproducts in a bottom-up synthesis approach using hydrothermal degradation of carbohydrate solutions, their resultant photoluminescence shows promise for down-converting ultraviolet photons into the visible regime with an associated increase in quantum efficiency. Excitation emission matrices showed a wavelength dependent luminescence with peak emission at 430nm for an excitation at 340nm for carbon nanodot solutions, with a 90nm red shift in emission for films. Carbonaceous nanodot solutions were derived from thermal treatment of high-concentration glucose solutions at 120°C for a 48-hour period and then incorporated into Ruthenium-based dye-sensitized solar cell devices to enhance external quantum efficiency for high energy photons. Dialysis, combined with solid phase extraction, of carbon nanodot solutions retained photoluminescent properties while successfully allowing for carbon nanodot isolation in acetonitrile, the dye solvent used for sensitizing the TiO_2 nanocrystalline matrix. Additionally, the role of heated poly(ethylene)glycol (a common binder incorporated into the cell's counter-electrode, as used by various other groups) is explored as an additional contributor to photoluminescence in dye sensitized solar cells and the resultant increase in efficiency. Photoluminescence and external quantum efficiency of these carbon nanodot-modified devices are shown, including a nearly 800% increase in quantum efficiency at an excitation of 340nm, verifying this low-cost, earth abundant approach to efficiency enhancement of dye-sensitized solar cells for the practical utilization of photovoltaics on Earth and in sustainable space exploration. From: NASA Nebraska Space Grant & EPSCoR, Omaha Public Power District, Creighton University Center for Undergraduate Research and Scholarship.

DESIGN OF KINETIC TILE THROUGH THE APPLICATION OF PIEZOELECTRIC ENERGYHARVESTING

Caleb Osmond, Department of Physics, Hastings College, Hastings, NE 68901

Despite the uncertainties that have manifested recently, there has been one aspect that will remain constant for the foreseeable future: humanity’s reliance upon electrical energy. In the past twenty years, there has been a significant technological emergence causing rapid integration of electronics into nearly all aspects of our lives. Whether it be the recent shift towards electrically powered transportation or reluctantly participating in another Zoom™ meeting, our need and

dependence on electrical energy isever-increasing. To mitigate the environmental impact of extracting this energy, researchers have focused their efforts on energy-harvesting techniques to help preserve our depleting fossil fuels, combat climate change, and meet this unprecedented demand. A handful of energy harvesting techniques already exist; wind, solar, and hydro-electric methods are considered the most notorious. But atthis juncture, piezoelectric energy harvesting is the least developed. Using the crystalline natureof specified piezoelectric elements, one can extract electrical energy from mechanical stresses. Or from ambient vibrations that are inconspicuously propagating in our environment at this very moment. The sources of these vibrations vary drastically in frequency, amplitude, and causation. These sources, ranging from car movement on roads and trains on their tracks to the typical everyday pedestrian commute, are subtle enough to go undetected by an unwitting observer. By targeting these specified sources of vibrations, one can reasonably deduce that they should be considered wasted energy that piezoelectric components can instead extract if given the right environment and choice of piezoelectric. As a result, the purpose of this study is to design and determine the large-scale feasibility of a piezoelectric tile that can extract mechanical energy from pedestrians in densely populated foot-traffic areas.

ρ′ PHOTOPRODUCTION IN ULTRA- PERIPHERAL HEAVY ION COLLISIONS WITH THE ALICE DETECTOR

G.A. Shani Nimeshika Perera, Department of Physics, Creighton University, Omaha, NE 68178

The Large Hadron Collider (LHC) in Geneva is the world's largest and most powerful particle accelerator. It accelerates fully ionized lead nuclei to a collision energy of $\sqrt{s_{NN}}$ = 5.02 TeV. The collider has four collision points and the ALICE (A Large Ion Collider Experiment) detector surrounds one of these collision points. When heavy nuclei like lead are directed at each other they can collide centrally, or they can miss each other. When the two nuclei miss each other (with an impact parameter greater than twice the lead-ion radius), it is called an ultra-peripheral collision. Since there are no hadronic interactions in ultra-peripheral collisions, the nuclei do not interact via the nuclear force but rather the long-range electromagnetic force. The ultra-peripheral Pb-Pb collisions can produce excited ρ mesons which decay into $\pi^+\pi^-\pi^+\pi^-$. I present the analysis procedure used to select these events and the results I obtained for the coherent photoproduction of ρ' mesons at a collision energy of $\sqrt{s_{NN}}$= 5.02 TeV. STARlight Monte Carlo simulations are used to understand the detector acceptance and efficiency.

MATHEMATICAL MODELLING OF IMPEDANCE-BASED CELL MIGRATION FOR PHYSICS OF CANCER

Melanie Schwengler, Andrew Walther, and Michael Mimlitz, Department of Physics, Creighton University, Omaha, NE 68178; Harry Kramer, Jack Lewison, and Megha Jacob, Department of Biology, Creighton University, Omaha, NE 68178; Joe Bamesberger, Department of Chemistry, Creighton University, Omaha, NE 68178; and Dr Andrew Ekpenyong, Department of Physics, Creighton University, Omaha, NE 68178

Physics of Cancer is a novel research frontier which seeks to unravel the role of physical interactions and mechanical forces in metastasis. Metastasis itself is the complex process by which

cancer cells spread from the primary tumor to other tissues and organs of thebody where they form new tumors. It leads to over 90% of all cancer deaths. An important stepin the metastatic cascade is migration. Various chemotherapeutic and radiotherapeutic approaches target cancer cell proliferation and not metastasis. We have recently quantified extensively, the impact of these approaches on cancer cell migration, using bioimpedance as a readout. Here, we present mathematical models for our vast experimental data which provide mechanistic insights into the role of various chemotherapeutic and radiotherapeutic approacheson cancer metastasis. Having recently used a commercially available Electric Cell Impedance Sensor (ECIS) to quantify the migration of various cancer cell lines following chemotherapy and following radiotherapy(using a cell irradiator, Faxitron), we applied equivalent circuits andpower-law equations to model the complex impedance data, using MATLAB codes. Fits of equivalent circuit models and power-law models quantify and characterize the raw impedance data for neuronal cells, brain cancer cells and macrophages. Moreover, even without data fitting, we find that the irradiated HCN2 cells (neurons) and T98G cells (Glioblastoma, brain cancer cells) attach and migrate significantly more than non-irradiated cellsin the first 20 hours post irradiation. The model parameters such as the power-law exponent capture the increased migration of irradiated cells prior to cell death, providing robust and biophysically relevant insights into metastasis which can potentially inform urgently needed anti-metastasis strategiesin cancer treatments.

PHOTONUCLEAR PRODUCTION OF THE PHI MESON IN ULTRA-PERIPHERAL COLLISIONS AT STAR

Johnny Zigmond, Department of Physics, Creighton University, Omaha, NE 68178

The STAR detector at the relativistic heavy ion collider (RHIC) has been used to study ultra-peripheral collisions (UPCs) between gold nuclei. Instead of steering the two beams so that the nuclei collide into each other, ultra-peripheral collisions involve bringing the nuclei close enough to each other to interact primarily electromagnetically instead of hadronically. These ultra-peripheral collisions can lead to the production of the phi meson. The phi meson decays quickly into a kaon pair (K^+ and K^-), which if observed can be used to reconstruct the phi meson. Simulating the photonuclear production of phi mesons in relativistic ultra-peripheral gold+gold collisions using the Monte Carlo STARlight allows us estimate detection rates and develop selection criteria for the data. We will discuss the Monte Carlo simulation, explain how selection criteria are determined, and how the parent particle is reconstructed experimentally from the daughter particles that we detect. Ongoing research is currently analyzing data acquired from the STAR detector for evidence of the photonuclear production of phi mesons in gold+gold collisions at 200 GeV per nucleon.

TEACHING OF SCIENCE & MATHEMATICS

Chairperson: Susan Weller
University of Nebraska-Lincoln

FRIDAY, APRIL 23

MORNING SESSION - 1

8:45 ZOOM Session opens for participants to join https://unl.zoom.us/j/97859283715

9:00 WELCOME

9:05 CLASSROOM PARTICIPATION 2.0. Phyllis Higley (abstract)

9:25 TEACHING ECLIPSES WITH SMARTPHONES. Kevin M. Lee and Christopher M. Siedell (abstract)

9:45 THE USE OF OOBLECK AS A CLASSROOM DEMONSTRATION. Robert Spurlin and Mary Keithly (abstract)

10:00 **BREAK**

12:00 **LUNCH**

1:00 **BUSINESS MEETING** https://unl.zoom.us/j/97870996278
Nebraska Academy of Sciences (all members)
State of the Academy
Awards Ceremony
Vote by NAS members on Revisions to NAS Constitution
Comments from Members-at-Large

1:30-2:30 **MAIBEN LECTURE** https://unl.zoom.us/j/9289316099
Dennis Ferraro, *Reflections of a Nebraska Herpetologist*

TEACHING OF SCIENCE & MATHEMATICS ABSTRACTS

CLASSROOM PARTICIPATION 2.0

Phyllis Higley, Department of Biology, College of Saint Mary, Omaha, NE 68106

Prior to the pandemic, I encouraged classroom participation by giving points for attendance and asking review questions at the beginning of class sessions. With the pandemic,I needed a way to incentivize participation even when students were quarantined. I routinely recorded lectures using VidGrid; consequently, students can watch my lectures from home. Toensure that students are actively engaged with the material, I verbally asked a question in eachclass session that the students (both those who attend in person and those who watch the recording from home) answer in their own 1–2-minute VidGrid recording. Each answer earned up to 4 points, depending on the quality of response. Questions may be sharing their muddiest point, looking up an example of a concept covered in class, summarizing a concept covered in that class period, or making connections between related concepts. After reviewing student responses, I can pinpoint misconceptions and address them in the following class session. My goal was to increase student contact with the material to help them learn but identifying misconceptions has proven to be a valuable tool that helps me more effectively present material.

TEACHING ECLIPSES WITH SMARTPHONES

Kevin M. Lee, Christopher M. Siedell, Center for Science, Mathematics, &
Computer Education, University of Nebraska-Lincoln, Lincoln, NE, 68588-0299

This presentation will describe early efforts of using student smartphones in and outof the college astronomy classroom. The prevalence of these devices and the strong connection that our students have for them provide a unique opportunity for students to connect with science content. Examples of html5 simulations with embedded questions will be shown for teaching eclipses. High-quality publicly available content and clearly specified“best practices” will be needed for this pedagogy to become widespread. This work was funded by the NASA Nebraska Space Grant.

THE USE OF OOBLECK AS A CLASSROOM DEMONSTRATION

Robert Spurlin and Dr. Mary Keithly, Department of Science, Chadron State
College, 1000 Main St., Chadron, NE 69337

The core of this research revolves around oobleck as a demonstration for lower grade-level science classes in junior and senior high school. The main research areas will be in the ratio of water tocornstarch and its effect on the viscosity and properties of the oobleck. This demonstration will benefitteachers who could use it in their classrooms to help a number of students. Another interesting aspect is seeing how other liquid reagents may affect the mixture and non-Newtonian properties that make oobleck so interesting in the first place. A variety of liquid reagents and ratios for mixtures will help students see different properties and make the demonstration more interesting and appealing to students. This will get students involved with making mixtures in the demonstration, this will add a hands on experience that will allow students to be more involved and interested in the demonstrations. The goal is to provide a well-developed demonstration that teachers can use in a variety of classes. We hypothesize that liquids similar to water will work best, but the oil and dish soap will yield different results as they are very different from water. Primary focus will be a demonstration to set the scene fordiscussions and lectures over properties

of solids, liquids, and gases for teachers to use anywhere. The methods will be simple just mixing the 5 reagents (water, vinegar, milk, dish soap, and oil) in 5 different ratios (1:3, 1:2, 1:1, 2:1, 3:1). Each mixture will be tested to see how each reagent works in different ratios. An electric mixer was used on medium speed to test the properties of the mixture and then a score was assigned (from 0-5) based on the properties of the mixture as a solid and a score assigned (0-5) on the properties as a liquid. Water was found to be the best reagent, followed closely by vinegar and milk, with the ratio 2 parts cornstarch to 1 part water. The dish soap and oil yielded very interesting results and worked better in ratios with more liquid and less cornstarch. The original hypothesis was supported: liquids similar to water worked best and generally required slightly more cornstarch than liquid. The main group to benefit from this research would be teachers in the state of Nebraska, as the research is designed to help with phenomenon based learning standards in Nebraska.

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Special recognition goes to the University of Nebraska-Lincoln's Center for Science, Mathematics and Computer Education for hosting our Annual Meeting on Zoom, and for online organization associated with registration, abstract submission, and program development, and all the time and effort that entails.

NEBRASKA ACADEMY OF SCIENCS FRIEND OF SCIENCE AWARD WINNERS

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2020	Tiffany Heng-Moss, Lincoln
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2006	Ed Brogie, Wayne
2006	Judy Williams, Central City
2005	Charles Lang, Uehling
2005	Kathleen Jacobitz, Pawnee City
2004	Charles Holliday, Omaha
2003	Ms. Tranda Fischelis, Philadelphia, PA
2002	Robert and Martha Kaul, Lincoln
2001	Henry Baumgarten, Lincoln
2001	Claire Oswald, Omaha
2000	David T. Lewis, Lincoln
1999	Albert W. Zechman, Lincoln

YEAR	WINNER
1998	Robert B. Nelson, Lincoln
1997	Francis A. Haskins, Lincoln
1997	Robert B. Johnston, Lincoln
1997	M. Rosalind Morris, Lincoln
1996	T. Mylan & Eunice Earhart Stout, Lincoln
1993	Virginia Smith, Chappell
1992	Florence Boring Lueninghoener, Fremont
1989	Robert W. Allington, Lincoln
1984	Lewis E. Harris, Lincoln
1981	Mr. & Mrs. Thomas C. Woods, Jr., Lincoln
1980	George & Olivia Lincoln, Lincoln
1977	Vance D. Rogers, Lincoln
1976	Walter D. Behlen, Columbus
1970	Mabel L. Criss, Omaha

***2021 FRIEND OF SCIENCE AWARD TO*:**

DR. PAUL KARR

Dr. Paul Karr is a professor of Chemistry at Wayne State College. During his tenure at WSC Dr. Karr has taught a variety of courses including general education science, general chemistry I and II, environmental chemistry, and physical chemistry I and II. He and Dr. Young, along with several students, developed a series of *Science On-The-Road Shows*, which were designed to generate interest in the sciences in K-12 students. The shows were delivered to several area middle and high schools from 1998 until 2003. Beginning in 2008, when Dr. Young became director of the Fred G. Dale Planetarium at Wayne State College, Dr. Karr began serving as an assistant, helping prepare the planetarium for public shows and delivering public shows.

Dr. Karr is part of an international research coalition and has worked with collaborators around the globe including scientists in Japan, India, Spain, Canada, Greece, Germany, Spain, and England. As part of the group Dr. Karr has co-authored over 70 scientific papers, which have been published in several peer-reviewed journals including but not limited to The Journal of Physical Chemistry, The Journal of Organic Chemistry, The Journal Porphyrins and Phthalocyanines, and Chemical Physics/Physical Chemistry. Not only is Dr. Karr an active researcher, he has also served as a peer-reviewer for over 30 science research papers.

Dr. Karr is currently part of a research group consisting of four Wayne State College students with collaborators at The University of Minnesota-Duluth, The Universitas Miguel Hernandez, Spain, The National Institute for Materials Science, Japan, and the University of North Texas. The Wayne State College group's research component utilizes the supercomputers maintained by The Holland Computing Center and focuses on the investigation of novel materials for use in electronics, as solar energy collectors, as chemosensors, and as anti-cancer agents.