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and
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THE NEBRASKA ACADEMY OF SCIENCES

1880-2022

Including the

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Nebraska Junior Academy of Sciences (NJAS) Affiliate

and

Affiliated Societies

141th Anniversary Year

One Hundred- ***Annual Meeting***

April 22, 2022

Hybrid Meeting

NEBRASKA WESLEYAN UNIVERSITY | ONLINE

LINCOLN, NEBRASKA

THE NEBRASKA ACADEMY OF SCIENCES, INC.

302 Morrill Hall, 14th & U Streets
Lincoln, Nebraska 68588-0339
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Affiliated with the American Association for the Advancement of Science
And
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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 for 49 years.

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.

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Day off remote conference support provided by the:

NAS ANNUAL SPRING MEETING 2022
Schedule at a Glance

2022	Olin 110	Remote	Remote	Acklie 218	Acklie 218	Olin 112	Olin LH-A	Olin LH-B	Olin lower Planetarium	Acklie 211	Acklie 207	Acklie 207	Acklie 007
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5:00	Social Event - LUX Center for the Arts												
7:00													

Aeronautics & Space Science Chairperson(s): Dr. Scott Tarry & Michaela Lucas

FRIDAY, APRIL 22

AERO SESSION – A (Tarry) **Location: Zoom/Virtual**

7:45 ZOOM Session opens for participants to join (https://unomaha.zoom.us/j/94205263954)

If you need assistance connecting via Zoom, or finding the right session, please contact the Home Room Support team

8:00 WELCOME

8:05 MUSCLE METABOLISM MEDIATES MICRO-VESSEL BLOOD FLOW DURING LOCAL HEATING. Cody Anderson, Elizabeth J. Pekas, Michael F. Allen, Andres Benitez-Albiter, Campbell Mooney, and Song-Young Park (abstract)

8:20 IMPACT OF SEX ON ARTERIAL STIFFNESS RESPONSES TO PROLONGED SITTING IN A MILD HYPERCAPNIC ENVIORNMENT. Andres Benitez-Albiter, Elizabeth J. Pekas, Michael F. Allen, Cody P. Anderson, Campbell Mooney, and Song-Young Park (abstract)

8:35 THE EFFECT OF VIRTUAL HEADING ERROR ON ONE'S ABILITY TO PERCEIVE OPTIC FLOW WHILE WALKING. Stephanie Mace and Mukul Mukherjee (abstract)

8:50 MODULAR ROBOTIC EXOSUIT (MORS) FOR POSITION PERCEPTION DETECTION IN ASTRONAUTS DURING SPACE MISSIONS. Takashi Sado, Carl Nelson, Jose Baca, and Mukul Mukherjee (abstract)

9:05 IMPACT OF SEX ON MACROVASCULAR ENDOTHELIAL FUNCTION RESPONSES TO PROLONGED SITTING IN A MILD HYPERCAPNIC ENVIORNMENT. Campbell Mooney, Elizabeth J. Pekas, Michael F. Allen, Cody P. Anderson, Andres Benitez-Albiter, and S0ong-Young Park (abstract)

9:20 INTERRUPTIONS WITH PASSIVE AND ACTIVE LEG MOVEMENTS PROTECT VASCULAR FUNCTION DURING PROLONGED SITTING IN A MILD HYPERCAPNIC ENVIRONMENT. Elizabeth J. Pekas, Michael F. Allen, Cody P. Anderson, Andres Benitez-Albiter, Campbell Mooney, and Song-Young Park (abstract)

9:35 PRINTER VARIABILITY AND THE IMPACT ON RESIN PHYSICAL PROPERTIES, AN IN VITRO STUDY. Isaac Langan and Heath Ketteler (abstract)

9:50 DEVELOPMENT AND TESTING OF RECYCLABLE ANTIMICROBIAL MATERIALS FOR IN-SPACE MANUFACTURING OF MEDICAL DEVICES. A. J. D'Ovidio, A. Acuña Velásquez, N. Stergiou, B. A. Knarr, and J. M. Zuniga (abstract)

10:00 BREAK

10:20 INITIAL RESULTS OF TESTING THE ACCRETION DISK WIND MODEL FOR QUASAR MASS OUTFLOWS. Jeffrey Brozek and Jack Gabel (abstract)

10:35 COMPARING ACCRETION DISK SIMULATIONS WITH OPTICAL VARIABILITY DATA TO INVESTIGATE VARIABLE QUASAR EMISSION. Alan Roden, Jack Gabel, and Shrey Ansh (abstract)

10:50 OBSERVING THE HYDROTHERMAL DEGRADATION SYNTHESIS OF D-GLUCOSE DERIVED CARBON NANODOTS AND THEIR FLUORESCENT PROPERTIES. Max Markuson-DiPrince (abstract)

11:05 USING REMOTE SENSING TO STUDY THE EFFECT OF CLIMATE AND LAND USE ON BLOWOUTS IN THE NEBRASKA SANDHILLS. John Quigley and Mary Ann Vinton (abstract)

11:20 TROPICAL GEOMETRY AND THE PARAMETRIC SHORTEST PATH PROBLEM FOR ROUTING IN DELAY TOLERANT NETWORKS. Jacob Cleveland and G. Griffith Elder (abstract)

11:35 DESIGN AND ENGINEERING SURFACES FOR REPELLENCY TO LOW SURFACE TENSION FLUIDS VIA FLSP AND CVD. Garrett Beard, Craig Zuhlke, Siamak Nejati, Syed Ibrahim, and Ryan Healey (abstract)

11:50 WETTABILITY CHANGES OF ULTRA-SHORT PULSED LASER PROCESSED SILVER WITH EXPOSURE TO AIR. Graham Kaufman, Siamak Nejati, and Craig Zuhlke (abstract)

12:05 THE EFFECT OF FEMORAL NECK GEOMETRY ON BONE MICROSTRUCTURE. Travis McCumber, Sophie Gart, and John Hao (abstract)

12:20 MECHANISMS OF MITOXANTRONE ACTION IN HR-DEFICIENT CANCERS. Savanna Wallin and Gloria E. O. Borgstahl (abstract)

MUSCLE METABOLISM MEDIATES MICRO-VESSEL BLOOD FLOW DURING LOCAL HEATING

Cody P. Anderson[1], Elizabeth J. Pekas[1], Michael F. Allen[1], Andres Benitez-Albiter[1], Campbell Mooney[1], Song-Young Park[1], codypanderson@unomaha.edu
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Reduced skeletal muscle metabolism in micro-gravity may lead to elevated peripheral vascular resistance and a reduction in peripheral blood flow, thereby leading to deleterious long-term adaptations to the vascular endothelium, which is implicated in the development of cardiovascular diseases. Peripheral vascular resistance can be reduced by local heating, which does not increase core-temperature; however, the mechanism(s) underlying reduced peripheral vascular resistance in the skeletal muscle micro-vessels during heating remains enigmatic. Therefore, the purpose of this study was to determine potential mechanism(s) by which local heating decreases skeletal muscle micro-vascular resistance. Healthy young adults (n=8) participated in this study. A topical heating pad was circumferentially wrapped around the antebrachium and was heated to 45°C for 30 min, and thermistors were used to monitor skin temperature. Near-infrared spectroscopy (NIRS) was utilized to monitor micro-vessel dynamics: Spectral analysis techniques were used to assess mechanisms of vasodilation, the arterial occlusion method was used to assess tissue metabolic rate, and the venous occlusion method was used to assess micro-vessel blood flow. Heart rate variability (HRV) analysis was performed to assess global autonomic activity. The frequency intervals of 0.01-0.04 Hz (VLF), 0.04-0.15 Hz (LF), and 0.15-0.4 Hz (HF) were used to represent sympathetic, and parasympathetic nervous system activities. During heating, skin temperature increased (Δ4.49±0.96°C) (P<0.01), and the change in skin temperature was strongly associated with the change in micro-vessel blood flow (r=0.9, P<0.01). Micro-vessel blood flow and tissue metabolic rate were both elevated after local heating (Δ2.50±1.77 a.u.·s^{-1}, P<0.01; Δ0.20±0.27 a.u.·s^{-1}, p=0.03, respectively). Average HRV spectral energy in the VLF, LF, and HF intervals (global autonomic activity) was not altered during heating, but average spectral energy in the 0.15-0.4 Hz interval was elevated in the NIRS signal (local autonomic activity) (Δ0.0049±0.08 a.u.·s^{-1}, P=0.02) and was associated with the change in tissue metabolic rate (r=-0.9, P<0.01). These data indicate that muscle metabolism may be a major mechanism for local heating-initiated vasodilation. Furthermore, our results indicate that local but not global autonomic activity is modulated during the vasodilatory response to local heating. Therefore, we conclude that local heating reduces micro-vessel resistance, and interventions that utilize local heating to reduce micro-vessel resistance in micro-gravity should target metabolism as a mechanism to initiate vasodilation in skeletal muscle.

IMPACT OF SEX ON ARTERIAL STIFFNESS RESPONSES TO PROLONGED SITTING IN A MILD HYPERCAPNIC ENVIORNMENT

Andres Benitez-Albiter[1], Elizabeth J. Pekas[1], Michael F. Allen[1], Cody P. Anderson[1], Campbell Mooney[1], Song-Young Park[1], abenitezalbiter@unomaha.edu
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Prolonged sitting (sitting for 1+ h at a time) has been shown to have negative repercussions on vascular function. Our group previously showed that prolonged sitting in a mild hypercapnic environment (elevated carbon dioxide concentrations to a level comparable to crowded spaces, such as offices and airplane cabins) can further attenuate sitting-induced endothelial dysfunction in healthy young adults. More recently, we demonstrated that active muscular contraction provides macrovascular function protection during prolonged sitting in healthy young adults. Interestingly, there were no sitting-induced alterations in arterial stiffness in either of these studies, which may be partially due to our study populations being active healthy young adults. Arterial stiffness is more prevalent in middle-to-older age populations, and therefore prolonged sitting in a mild hypercapnic environment may have a greater impact on the stiffening of arteries in a middle-aged population, such as office workers. Office workers account for one of the largest portions of the total U.S. workforce, and this population is frequently exposed to prolonged sitting in mild hypercapnic environments. Therefore, this study aimed to 1) explore the influence of active muscular contraction on arterial stiffness during prolonged sitting in a mild hypercapnic environment in middle-aged office workers and 2) investigate if these impacts were different between sexes. Middle-aged office workers (n=14, age 40.0±6.4 y) participated in 2 visits that included sitting for 2.5 h in a mild hypercapnic environment: control (CON, no muscular contraction) and active leg movement (ACT) during sitting. Central and peripheral arterial stiffness was assessed by pulse-wave velocity (PWV) before and after prolonged sitting in both groups. No statistically significant differences (P>0.05) were noted in carotid-to-femoral (central arterial stiffness) or carotid-to-ankle (peripheral arterial stiffness) PWVs. However, effect size analysis (Cohen's d), which measures the strength of relationships, revealed that sitting-induced changes (Δ, post-pre) in carotid-to-femoral PWV were lower in ACT vs. CON in males (d=0.6, moderate effect size) whereas females showed no apparent differences between ACT and CON (d=0.3). Similarly, sitting-induced changes in carotid-to-ankle PWV were lower in ACT vs. CON in males (d=0.6, moderate effect size) and no change was detected in females (d=0.3). Therefore, these preliminary results may indicate that sitting interruptions with intermittent active leg movements may protect against sitting-induced increases in arterial stiffness in males; however, there were no sex differences in arterial stiffness in response to prolonged sitting in a mild hypercapnic environment with or without active leg movement interruptions.

THE EFFECT OF VIRTUAL HEADING ERROR ON ONE'S ABILITY TO PERCEIVE OPTIC FLOW WHILE WALKING

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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. There is also a change of the interaction between the astronaut and their environment. For example, when you are in space, you are unstable and not able to walk normally and need to bounce place to place to reach your targeted area. 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 a limitation 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 are significantly different from that on Earth with critical implications on space travel and space research. Specific to the visual system, there is a current lack 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, but it would also present the opportunity of training astronauts before and during spaceflight in hopes of limiting any visual deficits that occur during their time in space. 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 various speeds 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 virtual heading error that the 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 more sensitive 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.

MODULAR ROBOTIC EXOSUIT (MORS) FOR POSITION PERCEPTION DETECTION IN ASTRONAUTS DURING SPACE MISSIONS

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Microgravity may trigger an impaired sense of limb and body position during space travel. This may happen due to the degeneration of the proprioceptive neural fibers, muscle atrophy, and reduction in muscle tone for prolonged periods. We are developing a device, the Modular Robotics Suit (MORS), which will provide a highly adaptable, reusable, low-cost, and efficient means of exercising different muscle groups to mitigate and/or remedy muscle atrophy. This is important because in microgravity, astronauts need little muscle contraction to support their bodies or to move around and consequently, resulting in muscle atrophy over time. Loss of muscle mass and strength during spaceflights has been reported to pose both operational and medical risks to crew members. When muscle mass and strength is reduced and muscle contraction is low, there is a reduction in golgi tendon organ and muscle spindle functionality impairing the sense of limb position and movement. This leads to our main research question: can we utilized our MORS device to identify signs of position sense deficits during joint movement that could potentially impede functioning in astronauts during and after long duration space missions? The current MORS prototype is designed to provide resistance-based exercise and is being developed for use in altered gravity environments. We plan to develop the next version of the MORS device which will comprise of fitting the device with inertial sensors (IMU) to monitor position changes during specific movement tasks. Position sense disrupting tactors will also be fitted into the MORS to predict the effects of position sense deficits on functional tasks. Therefore, we propose three aims. Aim1: to develop a MORS prototype with additional position sensors and vibrotactors. Tactors will be attached inside each modular device to provide vibrotactile signals to the primary tendons moving the joint. Functionality of the IMUs and vibrotactors within the MORS will be tested. Aim2: to determine joint position sense in perturbed and unperturbed states using the MORS. We plan to recruit 20 healthy young adults. They will perform 4 different tasks in random order with the MORS device for wrist and elbow joints for the upper limb and the ankle and knee joints for the lower limb. Aim3: to determine a predictive model of position sense during and post-long duration space missions. In order to develop predictive models of sensorimotor control of movement, data sets from Aim#2 will be used to develop and fine tune machine learning models.

IMPACT OF SEX ON MACROVASCULAR ENDOTHELIAL FUNCTION RESPONSES TO PROLONGED SITTING IN A MILD HYPERCAPNIC ENVIORNMENT

Campbell Mooney[1], Elizabeth J. Pekas[1], Michael F. Allen[1], Cody P. Anderson[1], Andres Benitez-Albiter[1], Song-Young Park[1], cmooney@unomaha.edu
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Sedentary lifestyle and time spent sitting have negative impacts on macrovascular function, which have been known to increase the risks for cardiovascular diseases. Specifically in mild hypercapnic environments (elevated CO_2 concentrations similar to crowded spaces such as offices or auditoriums), we have shown that the negative vascular effects from prolonged sitting become intensified. However, previous studies have shown that sitting interruptions using active muscular contraction can protect vascular function during prolonged sitting, and we recently showed that active muscular contraction can preserve macrovascular function during prolonged sitting in a mild hypercapnic environment. Despite this finding, the impacts of active muscular contraction during prolonged sitting in a mild hypercapnic environment in a population that is more at-risk for cardiovascular diseases is not well understood. Office workers, who make up one of the largest sectors in the US workforce, are often predisposed to prolonged sitting in mild hypercapnic environments, which may make them more at-risk for cardiovascular disease development. Therefore, we sought to investigate the impacts of active muscular contraction on macrovascular endothelial function during prolonged sitting in a mild hypercapnic environment in middle-aged office workers, and we sought to further compare differences in vascular responses due to sex. Office workers (n=14, 7 males and 7 females, age 40.0±6.4 y) participated in 2 study visits sitting for 2.5 h in a mild hypercapnic environment: control (CON, no leg movement) and active (ACT, intermittent bouts of active leg movement). Measurements of macrovascular endothelial function in the brachial and popliteal arteries were taken using flow-mediated dilation (FMD) before and after prolonged sitting in the CON and ACT groups. Popliteal artery FMD was greater in post-ACT compared to post-CON (P<0.01). Additionally, the sitting-induced change (Δ, post-pre) in popliteal artery FMD was higher in ACT compared to CON (P<0.01), and the sitting-induced reduction in popliteal artery FMD was protected in females in ACT (P<0.05) whereas no differences in sitting-induced changes were noted for males between CON and ACT (P>0.05). Furthermore, brachial artery FMD showed no differences between ACT and CON, and no sex differences in sitting-induced changes were noted (P>0.05). These preliminary results suggest that sitting interruptions with active muscular contraction can preserve macrovascular function in middle-aged office workers, and this preservation may be more potent in females compared to males in the lower extremity.

INTERRUPTIONS WITH PASSIVE AND ACTIVE LEG MOVEMENTS PROTECT VASCULAR FUNCTION DURING PROLONGED SITTING IN A MILD HYPERCAPNIC ENVIRONMENT

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Prolonged sitting has been reported as an independent risk factor for cardiovascular diseases, and certain professions are predisposed to large amounts of sitting time. Office workers sit for >75% of their workday, which typically occurs in conditions with poor air quality, such as high levels of carbon dioxide (mild hypercapnic environments). We and others have demonstrated that prolonged sitting has negative effects on macro- and microvascular function, and we recently showed that these negative effects are intensified in mild hypercapnic environments. Moreover, we recently investigated the major mechanisms of muscular contraction (group III and IV afferents) and their ability to protect vascular function during prolonged sitting in a mild hypercapnic environment in young adults. We found that group III afferent activation by passive leg movement can salvage microvascular function whereas group III/IV afferent activation by active leg movement can protect macro- and microvascular function. However, this study was performed in healthy young adults, and the impacts of group III and IV afferent activation on vascular function in a population more predisposed to prolonged sitting in mild hypercapnic environments is unknown. The present study aimed to investigate the impacts of intermittent passive and active leg movements on vascular function during prolonged sitting in a mild hypercapnic environment in middle-aged office workers. Office workers (n = 8, age 40.0 ± 3.9 y) participated in 3 study visits sitting for 2.5 h in a mild hypercapnic environment: 1) control (CON, no movement), 2) passive (PASS, passive movement), and 3) active (ACT, active movement). Measurements of macrovascular function (popliteal and brachial artery flow-mediated dilation, FMD) and microvascular function (near-infrared spectroscopy) were taken before and after prolonged sitting. Popliteal artery FMD was preserved post-sitting in PASS and ACT (P>0.05). Brachial artery FMD was attenuated post-sitting in CON (P<0.05) but was maintained post-sitting in PASS and ACT (P>0.05). There were no statistically significant changes in microvascular function (P>0.05); however, effect size analysis (Cohen's d) showed that sitting-induced changes (Δ, post-pre) in microvascular function were higher in ACT compared to CON and PASS (d=0.9 and 0.7, respectively, large effect sizes), whereas sitting-induced changes between CON and PASS were of small effect size (d=0.4). These preliminary results provide evidence that group III and group III/IV afferent activation may protect both macro- and microvascular function during prolonged sitting in a mild hypercapnic environment in middle-aged office workers.

PRINTER VARIABILITY AND THE IMPACT ON RESIN PHYSICAL PROPERTIES, AN IN VITRO STUDY

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Advancements in 3D printing technology are changing the way restorative dentistry is performed. Dental companies have developed 3D printed resins that have shown sufficient strength to be used as final indirect restorations. This technology has the potential to replace traditional milled ceramic materials which would decrease the cost and equipment needed to produce high quality indirect restorations. Due to widespread innovation, the number of 3D printers is quickly increasing. Thus, companies are not able to test their resins on all possible 3D printer and curing systems. The way a resin is cured can have huge implications on the properties of the final product. The goal of this experiment is to compare the compression and flexural strengths as well as the water sorption and solubility of a definitive crown resin that has been printed and cured using two different systems. The experimenters will use System A to print samples of appropriate size for each test. Post processing will be completed according to company recommendations. On the same day, technicians at the dental company will print identical samples using System B and perform the company recommended post processing. ISO 10477- 2020 will be followed to acquire flexural and compressive strength along with water sorption and solubility. The average values of Group 1 and Group 2 will be determined and compared for statistically significant differences. Instron servo hydraulic 8511+ will be used to determine compression and flexural strength. Sorption and solubility will be tested by first desiccating the samples to acquire a dried weight. The samples will then be soaked for 1 week to measure water sorption. Lastly, the samples will be desiccated a second time to produce a final weight demonstrating solubility. Results will be compared between the samples produced by the two different systems. Results of this study showed significant differences in the flexural strength ($p=0.0021$) and compressive strength ($p=0.0097$) between System A and System B. Although sorption between the two was not statistically significant ($p=0.0692$), the solubility difference was statistically significant (0.001). It can be concluded that the different printing and post processing systems have an impact on the solubility, flexural and compressive strength of the final product.

DEVELOPMENT AND TESTING OF RECYCLABLE ANTIMICROBIAL MATERIALS FOR IN-SPACE MANUFACTURING OF MEDICAL DEVICES

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The purpose of the study is threefold: (i) develop high-strength recyclable antimicrobial polylactic acid-based and polyurethane-based materials compatible with the additive manufacturing facility on the ISS, (ii) perform antimicrobial and mechanical testing of coupons utilizing an on-ground replica of the ISS additive manufacturing facility, and (iii) development and post-extrusion mechanical characterization of the test coupons and the 3D printed medical devices manufactured on-orbit. METHODS: High-Strength Polylactic Acid Based-Material Development-Advances in nanotechnology allow for the addition of diamond to enhance the strength of a recyclable, antimicrobial polylactic acid-based filament. Polyurethane-based Filament Development-The current polyurethane-based filament is a versatile biocompatible flexible filament embedded with a copper-based nanocomposite to confer biocidal activity. Antimicrobial testing-Antimicrobial effectiveness and longevity is tested by an independent laboratory, following ISO 22196 standards, before and after heat-based accelerated aging for a period of 1-month equivalent to 1-year period of aging (Situ Biosciences LLC, wheeling, IL, Chicago, USA) inoculated with bacteria, such as Methicillin-resistant staphylococcus aureus (MRSA). Samples are manufactured within identical ISS on-ground and in-orbit additive manufacturing facilities. Mechanical characterization-Mechanical characterization of material test coupons follow ASTM-D638 and ASTM-D695 standards. Medical device prototypes are characterized based on the device specific requirements following ASTM-D5083, ASTM-D790, and ISO-178 standards[1–3]. Development of Medical Device Prototypes-Medical device prototypes are designed and scaled using Autodesk Fusion 360 (Fusion 360, Autodesk, Inc., San Rafael, CA, USA). Prototypes include a mallet finger orthosis and a basic surgical kit consisting of 1 scalpel handle, 1 retractor, 1 iris scissors, 1 needle driver, 1 hemostat, and 1 Adson forceps. EXPECTED RESULTS: Preliminary work shows bacterial analysis of the current polyurethane-based material with 1% copper antimicrobial additive to be up to 99.99% effective against MRSA and Escherichia Coli (E. Coli), which holds promising potential applications[4–6].

INITIAL RESULTS OF TESTING THE ACCRETION DISK WIND MODEL FOR QUASAR MASS OUTFLOWS

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Quasars are supermassive black holes billions of times the mass of the sun surrounded by a solar system sized accretion disk that outshines all the stars in its host galaxy combined. Approximately 20% of quasars exhibit high velocity mass outflows as seen in blue-shifted absorption in the UV spectra. The UV spectra of 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 the initial results of our novel analysis of the radiation driven Accretion Disk Wind model for BAL. The physical kinematic parameters of the accretion disk wind were modeled in Python and used as the input parameters for a photoionization modeling application called CLOUDY to produce models of ionic column densities that we then compare to observations of BAL. Correlation coefficients are determined for the simulated and observed kinematic BAL parameters.

COMPARING ACCRETION DISK SIMULATIONS WITH OPTICAL VARIABILITY DATA TO INVESTIGATE VARIABLE QUASAR EMISSION

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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 engine for a quasar. The goal of the project is to determine the processes within the accretion disk that cause these immense luminosities. The project will attempt to accomplish this with two parts: 1) analyze data from several quasar databases, including the Sloan Digital Sky Survey(SDSS) and 2) use an existing simulation that models 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 the simulation 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. Initial comparisons of the data with the results from the simulation show that a possible explanation for the variability within quasar emission is a radial dependence that builds upon itself within the accretion disk. Further comparisons and investigations into the results of the two parts will help to determine constraints on the accretion process at different locations of the accretion disk will be found and conclusions about the accretion mechanism, which is the end goal, can be made.

OBSERVING THE HYDROTHERMAL DEGRADATION SYNTHESIS OF D-GLUCOSE DERIVED CARBON NANODOTS AND THEIR FLUORESCENT PROPERTIES

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The goal of this project is to enhance the ultraviolet quantum efficiency of dye sensitized solar cells with the use of a facile process producing fluorescent carbon nanostructures. The hydrothermal degradation synthesis process, a type of bottom-up approach to the formation of Carbon Nanodots (CNDs), develops a complex carbohydrate conversion with a concentration and aggregation dependent fluorescent product yield. Prediction of this process is challenging as various acids, unreactive carbohydrates, lignin strands, and intermediate molecular states are developed throughout the degradation process. This bottom-up approach, where saccharide rings are broken down, is utilized in the biomass industry as a means of deriving fuel-based alternatives to current CO2 emitting fuels. Specifically, “waste” biomass seeks to utilize simple molecular structures, such as 5-Hydroxymethylfurfural (5-HMF), which polymerize in the chemical degradation process of simple saccharide molecules. The most common polysaccharides present in many biomass organisms are lignocelluloses, which contain other common polysaccharides, such as cellulose and lignin. Cellulose, in particular, contains a variety of subunits of interest, most notably D-glucose. Due to its simple structure, D-glucose has the capability of breaking down into 5-HMF – and under a time-dependent, closed hydrothermal environment, we observe a unique fluorescent behavior – but also produces a vast number of other products (fructose, levilunic acid, formic acid, furfural, lactic acid, and levoglucosan). The production of 5-HMF is of interest to us because we hypothesize it has a direct pathway towards the unique concentration and aggregation dependent fluorescent behavior of produced CND solutions and their subsequent violation of the Kasha-Vavilov rule (excitation-independent fluorescence). Excitation-Emission Matrices show a photoexcitation dependence from 350nm to 490nm, with a time-dependent redshifting peak photoemission ranging from 420nm to 550nm. NMR, FTIR, and UV-Vis spectroscopy were used to confirm the formation of 5-HMF molecules, the presence of aromatic carbon, and π-π^* sp-2 and sp-3 bonding. This facile process is a potential means of enhancing photovoltaic efficiency with tunable fluorescence capabilities.

USING REMOTE SENSING TO STUDY THE EFFECT OF CLIMATE AND LAND USE ON BLOWOUTS IN THE NEBRASKA SANDHILLS

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The Nebraska Sandhills comprise one of the most intact temperate grassland ecosystems in the world and the largest grass stabilized sand dune region in the Western Hemisphere. Since the sandy soils of this region can be easily shifted by winds across the predominately treeless terrain, plant cover is essential for stabilizing the dunes. Drought, overgrazing, or other disturbances can cause decreases in vegetation, allowing formation of sandy depressions of wind erosion (blowouts). Studies have shown a trend of decreasing blowout size over the previous twenty-five period (1980-2005). We utilized National Agriculture Imagery Program (NAIP) imagery to determine the current trend of blowout size in this most recent decade (2009-2018). Furthermore, 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 aircraft-imagery as well as images taken from a DJI Phantom 4 Pro V2.0 drone to detect small-scale changes in vegetation in topographically identical grazed and ungrazed plots. Normalized Difference Vegetation Index (NDVI)—an index of greenness generated from reflectance in the red, visible, and near-infrared regions of the electromagnetic spectrum—was used to calculate the relative quantity of vegetation present. Results indicate that blowouts have continued to decrease in size, perhaps due to a pattern of increased rainfall and temperature over the decade. Drone imagery indicates that cattle grazing can decrease NDVI, which suggests grazing can lead to a decline in vegetation and an increase in blowout formation. This finding emphasizes the importance of rotational grazing to prevent an over-grazing of plots. Overall, our study on blowout dynamics in the Nebraska Sandhills contributes to a more complete understanding of the sustainability and conservation of this unfragmented landscape in a future with a changing climate.

TROPICAL GEOMETRY AND THE PARAMETRIC SHORTEST PATH PROBLEM FOR ROUTING IN DELAY TOLERANT NETWORKS

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Delay Tolerant Networking (DTN) is the current approach to networking for space assets. In space, link characteristics between e.g. satellites and ground stations vary wildly. These characteristics depend, inter alia, on orbital mechanics and asset availability. Current routing solutions involve applying Dijkstra's algorithm to contact graphs. An alternative method is proposed here that views the problem of routing through a parametric graph via the lens of tropical geometry. Such a lens has already seen successful applications to train scheduling, job assignment, and even terrestrial networking. Several implementations based on such a method are explored, including two Python programs and a Verilog implementation.

DESIGN AND ENGINEERING SURFACES FOR REPELLENCY TO LOW SURFACE TENSION FLUIDS VIA FLSP AND CVD

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It is now well known that femtosecond laser surface processing (FLSP) can be used to create superhydrophobic surfaces, or surfaces that repel water. Combining FLSP with chemical vapor deposition (CVD) allows for selective control over the surface chemistry to optimize wetting properties. With optimized FLSP parameters and surface chemistry, FLSP surfaces exhibit near perfect repellency of water. Perfect repellency constitutes a contact angle between the surface and liquid droplet of 180°. Surfaces which can repel liquids other than water are desirable. One application for these surfaces is a liquid acquisition device (LAD) for use in cryogenic propellant tanks. Moving from developing surfaces that are hydrophobic to surfaces that are cryophobic is not trivial. Water has a surface tension of 72.7 mN/m. Liquid oxygen (the most common cryogenic oxidizer used in rocket engines) has a surface tension of 13.2 mN/m. As surface tension decreases, the level at which a liquid will be repelled decreases non-linearly. In this study we examined a small subset of the possible combinations of FLSP and CVD on aluminum, stainless steel, and titanium. Mound-like surface structures with a high aspect ratio are used to minimize possible contact locations. CVD was used to deposit low surface energy compounds on the mound-like surface structures. All three materials are tested against five liquids: water (72.7 mN/m), toluene (27.9 mN/m), isopropyl alcohol (22.3 mN/m), ethanol (22.0 mN/m), and perfluoroether (16.0 mN/m). A contact angle >90° is reported for all three materials and four of the five liquids. Perfluoroether has a contact angle of 0° for all three materials. Further optimization of this novel approach is possible. Fully understanding the fluid-surface interactions will help drive optimization efforts. Scientists at NASA's Marshall Space Flight Center (MSFC) are in the process of characterizing these surfaces in cryogenic conditions.

WETTABILITY CHANGES OF ULTRA-SHORT PULSED LASER PROCESSED SILVER WITH EXPOSURE TO AIR

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Femtosecond laser surface processing (FLSP) of metals creates metal and metal oxide surfaces with self-organized microscale structures that are covered with nanoscale texturing. This texturing leads to many useful properties, including extreme wetting and antimicrobial surfaces with applications to condensing heat exchangers for spacecraft. Many of the applications of FLSP surfaces rely on consistent wetting properties for device efficacy and longevity. Immediately after laser processing, metal FLSP surfaces are superhydrophilic but after prolonged exposure to the atmosphere, the surfaces become hydrophobic. FLSP silver surfaces were created by focusing pairs of femtosecond laser pulses spaced 120 picoseconds apart in time onto flat, clean silver. The bulk silver was translated back and forth relative to the focused laser spot, covering the bulk material in self-organized micro- and nano-scale features. Immediately after the laser processing, the surface was superhydrophilic. However, within minutes, the surface began to transition to become hydrophobic. In order to investigate the chemical changes on the surface of the FLSP sample that lead to the decrease in wetting, surface chemistry measurements were taken as a function of time using X-ray photoelectron spectroscopy (XPS) and auger electron spectroscopy (AES), two surface analysis techniques that are sensitive to the top approximately 10 nm of a surface. Using XPS and AES, the chemical state of the bulk silver surface was determined to be metallic before processing. Immediately after processing, the FLSP surface was found to be silver (I) oxide. After 15 minutes of atmospheric exposure, the FLSP surface began adsorbing carbon dioxide in the form of silver carbonate. The carbon dioxide adsorption continued over the course of the next four days. Simultaneously, the FLSP surface adsorbed hydrocarbons from the atmosphere, increasing the contact angle of water from 0° to 144°.

THE EFFECT OF FEMORAL NECK GEOMETRY ON BONE MICROSTRUCTURE

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Astronauts can lose up to 1% of their bone density per month due to "unloading" of bone in zero gravity. It is well established that mechanical loading is required to maintain bone mass and strength. In addition, femoral neck geometry (FNG, the angle resulting from the intersection of the long axis of the femoral shaft and the long axis of the femoral neck) has been shown to effect femoral torsion and predict the location of proximal femoral stress fractures. Femoral microstrain analysis and cortical and trabecular bone mapping estimates have been previously reported; however, the effect of FNG on bone microstructure has yet to be described. The purpose of this study is to use micro-computed tomography (micro-CT) to expand the fields understanding of femoral neck microstructure, the implications of FNG, and to potentially advance clinical diagnostic criteria. Methods: The femoroacetabular joint of ethically obtained, human cadaveric donors was visualized following the reflection of the musculature (superficial-lateral gluteal muscles, quadriceps femoris muscles, and musculature of the femoral triangle) that surrounds the proximal femur. The femoroacetabular joint capsule (iliofemoral, pubofemoral, and ischiofemoral ligaments) was incised circumferentially and the ligamentum teres femoris severed in order to disarticulate the joint. An oscillating saw was used to section and isolate the proximal femur with approximately 20 cm of subtrochanteric femoral shaft retained. Following sectioning, a digital protractor was used to determine FNG. FNG "normal" range is defined as 125º to 145º. Six femurs were selected based upon their FNG measurements. The six femurs included two femurs with FNG at 125º, two femurs with FNG at 135º, and two femurs with FNG at 145º. The oscillating saw was subsequently used to collect a disc-shaped, mid-femoral neck sample for micro-CT analysis (SkyScan-1172 micro-CT system, Bruker Corporation). Results: The resulting micro-CT analysis quantified the microstructural parameters of "normal" FNG range, including percent bone volume, connectivity density, structure model index, trabecular number, trabecular thickness, and trabecular separation. Conclusions: NASA's Human Exploration and Operations Mission Directorate and Human Research Program have organized hazards that astronauts encounter into five classifications, one of which is changes in gravity fields. This project quantified the microstructural parameters of "normal" FNG range which can be used to establish advanced diagnostic criteria that may need to be considered when addressing the impact of changing gravity fields on skeletal health and wellness. Future studies aim to quantify FNG microstructural parameters outside the "normal" FNG range.

MECHANISMS OF MITOXANTRONE ACTION IN HR-DEFICIENT CANCERS

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The use of RAD52 inhibitors has recently gained prominence as an ideal approach to selectively target homologous recombination-deficient cancer cells. RAD52 is a DNA repair protein associated with homologous recombination (HR), a pathway that mends double-stranded breaks (DSBs) in DNA. DSBs are the most deleterious form of damage and can be caused by various sources, including ionizing radiation. Several hereditary cancers have a propensity for HR deficiency, such as ovarian, breast, and pancreatic cancers. HR-deficient cancers are dependent on the complex formation of RAD52, and its binding partner, RPA. This complex is critical for HR-deficient cancer cells to repair DSBs in DNA and maintain genomic integrity. Identifying inhibitors of RAD52-based HR repair will provide a more selective and personalized form of therapy for patients with HR-deficient cancers. The Borgstahl lab recently identified mitoxantrone as a RAD52:RPA protein-protein interaction inhibitor through a high-throughput fluorescence-based protein-protein interaction assay, otherwise known as the FluorIA. Mitoxantrone is an FDA-approved chemotherapeutic that is well established in the clinic for the treatment of different leukemias and lymphomas. This anti-cancer therapy can be used as a monotherapy or in combination. Previously, this inhibitor was known to intercalate DNA and inhibit topoisomerase II, which targets DNA. This interaction with DNA induces damage such as strand breaks and crosslinks that interrupt cell division and impede proliferation, targeting tumor growth. This previously unknown protein-binding partner (RAD52) of mitoxantrone reveals more questions regarding novel potential mechanisms of action. The identification of mitoxantrone as an inhibitor of RAD52 also raises questions of other unknown protein-binding partners that may contribute to off-target effects associated with toxicity. We aim to characterize the interaction between mitoxantrone and RAD52 by understanding the binding kinetics and relative binding pocket to better define a novel tumor-killing mechanism of action for mitoxantrone through RAD52-inhibition. We also look to identify other previously unknown protein-binding partners through the development of a mitoxantrone-probe that may be used in varying cell lysates. Here, we aim to fully characterize the interaction between mitoxantrone and RAD52, as well as identify other unknown binding-partners that may contribute to toxicity. This new potential mechanism of action may extend its therapeutic application to HR-deficient cancers, expanding its use in the clinic, and will reveal additional unexplored interactions of mitoxantrone.

Aeronautics & Space Science Chairperson(s): Dr. Scott Tarry & Michaela Lucas

Moderator: Dr. Derrick Nero

FRIDAY, APRIL 22

AERO SESSION – B (Lucas) **Location: Zoom/Virtual**

7:45 ZOOM Session opens for participants to join (https://unomaha.zoom.us/j/99561536742)

If you need assistance connecting via Zoom, or finding the right session, please contact the Home Room Support team

8:00 WELCOME

8:05 DESIGN AND FABRICATION OF THE ANCHOR FOR NON-PENETRATIVE CONNECTION TO LUNAR AREAS (ANCLA). Carson Emeigh, Evan Griess, Trent Wiens, Mike Sheridan, Ben Zwiener, Lauren Wuderman, and Carl Nelson (abstract)

8:20 DEVELOPMENT OF A SAMPLE BAG DISPENSER CAPABLE OF COLLECTING LUNAR REGOLITH ON NASA MISSIONS. Larissa Wehling, Mary Ankenbauer, Cassandra Amsden, Isaac Regier, Tyler Stoeger, and Dr. Carl Nelson (abstract)

8:35 SMARTPHONE SIMULATIONS IN THE ASTRONOMY CLASSROOM. Kevin M. Lee and Christopher M. Siedell (abstract)

8:50 COLLEGE OF SAINT MARY ELEMENTARY OUTREACH PROGRAM 2021-2022. Macy Homes and Dr. Jennifer Grove (abstract)

9:05 BUILDING SELF-EFFICACY IN PRE-EDUCATION ELEMENTARY EDUCATION MAJORS. Derrick A. Nero (abstract)

9:20 AUGMENTING COMPUTER SCIENCE CIRRICULUM USING OFF-THE-SHELF ROBOTICS KITS MAKER PROJECTS TO ENHANCE WHOLE BRAIN AND BALANCED LEARNING. William Loring (abstract)

9:35 VIRTUAL REALITY FOR PHYSICS EDUCATION: GETTING STARTED. Natalie Schwartzenberger (abstract)

9:50 ENVIROBOT USING RASPBERRY PI BASED ROBOT TO EMULATE A MAR'S ROVER MISSION. Joann Jones (abstract)

10:00 BREAK

10:20 WOMEN IN STEM. Josie Schafer, Morgan Vogel, and Amanda Parker (abstract)

10:35 100K EXPERIMENTAL HYBRID ROCKET ENGINE DESIGN TEAM. Magdalene Peklo, Nick Swerczek, and Auston Viotto (abstract)

10:50 REPLACING A COMMUNICATION MODULE ON A MOVING MAST USING AN AUTONOMOUS DRONE. Zury Vasquez, Ryan Karl, Gabriel Becker, Timothy Gibbons, Zander Ziettlow, and Austin Bubak (abstract)

11:05 UNIVERSITY OF NEBRASKA-LINCOLN AEROSPACE LUNABOTICS COMPETITION TEAM. Johnathon Cerny, Angeline Luther, Aaron Norlinger, Justin Morrow, Nathan Simms, Lauren Plumley, and Zander Ziettlow (abstract)

11:20 LOW EARTH ORBIT MISSIONS FOR EDUCATION AND RESEARCH. Joel Murch-Shafer and John Helzer (abstract)

11:35 THE INVESTIGATION AND IMPLEMENTATION OF NANOGALVANIC ALLOYS FOR DEEP SEA AND DEEP SPACE APPLICATIONS. Melissa Holmes, Austin Dawe, Tobin Widhalm, Emmanuel Encina-Garcia, and Jake Sykora (abstract)

11:50 NITROUS OXIDE PRODUCTION UNDER NITRATE STIMULATED REDUCING CONDITIONS. Taylor Rosso, Daniel Miller, and Karrie Weber (abstract)

12:05 AN IN VITRO SYNTHESIS OF BACILLITHIOL. Abigail Klammer and Mary Keithly (abstract)

12:20 MONOCLONAL ANTIBODIES IN BREASTMILK OF VACCINATED WOMEN. Thea McFarland and Dr. Mary Keithly (abstract)

DESIGN AND FABRICATION OF THE ANCHOR FOR NON-PENETRATIVE CONNECTION TO LUNAR AREAS (ANCLA)

Carson Emeigh[1], Evan Griess[1], Trent Wiens[1], Mike Sheridan[1], Ben Zwiener[1], Lauren Wuderman[1], Carl Nelson[1], cemeigh2@unl.edu

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The University of Nebraska - Lincoln MicroG NExT team set out to develop a light, safe, and reliable anchoring mechanism that can assist future extraterrestrial missions by providing mounting surfaces for small and low mass objects. To make the device viable for space missions as well as ground-based testing, it must be a low mass, compact, and water-resistant device that does not use external pressure or chemical adhesives and is operable within earth's surface temperature range. It must allow reusable operation by astronauts in EVA (extravehicular activity) suits. The original design for this project was known as the "Compact Reusable Anchoring Apparatus to Connect to Novel Surfaces". This device consisted of an actuation shaft and multiple arms. The arms were held vertically by springs in the storage position. When the operator wished to deploy the device they would pull up on the actuation shaft, raising the arms from the vertical position. The operator would then place the device on the rock surface and release the actuation shaft. The springs in the arms forced the arms back into the vertical position, gripping them to the rock. After prototyping this device, the team found that the arms peeled up with minimal force and needed redesign. A weighted decision matrix was created, and the ANCLA design was selected. A mechanism was developed, known as ANCLA, capable of holding objects that produce up to a 10-pound force at any angle from a rock face of sizable diameter. ANCLA consists of 3 main components, a ground shaft, an actuation shaft, and a hook interface. The ground shaft is a stationary containment that houses the springs and other components of the device. The device is operated by pushing down on the designated top of the actuation shaft. As the actuation shaft slides down, it causes the hooks to protrude from their stowed position and spread out across the rock surface. The "primary" springs attached between the actuation shaft and the ground shaft provide the majority of the holding force. "Secondary" springs are attached between the actuation shaft and each of the hooks. These "secondary" springs give each hook more freedom to move independently from each other, avoiding over constraint and good interfacing with the rock. Through analysis of the deflection of the springs, theoretical calculations show that the device can hold against a 40-pound load. Further testing of the prototype to validate these calculations is ongoing.

DEVELOPMENT OF A SAMPLE BAG DISPENSER CAPABLE OF COLLECTING LUNAR REGOLITH ON NASA MISSIONS

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The University of Nebraska-Lincoln Micro-G NExT design team proposes a Tool for Handling Aggregate and Novel Samples (THANoS). This system consists of two main, functional components: the sample bags themselves and the bag dispensing housing. The intent of this device is to hold and dispense bags that astronauts can implement to collect regolith samples from the moon's surface. The bags must securely close and retain the sample, be operational using one hand only, as well as meet given weight and dimensional requirements. The specific design for the housing is as follows: the sample bags are stacked vertically within each other, with a staging notch holding the active, topmost bag, and dust guard bristles holding the lower, successive bags in place. The stack of bags is enclosed by the housing, with an open top to allow removal of the topmost bag. The bags themselves are designed with plastically deforming, ductile wires integrated into the side seams, and a sealing bar at the top opening of each, extending into a folding tab at the side of the bag. Additionally, each bag has a pull tab on the front face, designed for operators to pull open the bag while avoiding contamination via reaching inside the bag. Lastly, velcro is attached to the top opening of each bag to ensure sealing begins before the astronaut engages the folding tab. The deploying mechanism for a bag relies on the astronaut first pulling the bag open with the pull tab on the front facing side of the bag. Once a sample is placed inside the bag, the astronaut pushes the front face of the bag to the back face to engage the velcro at the top of the sample bag. The astronaut then uses the tab on the attached folding bar to lift the sample bag out of the staging notch and remove it from the housing. The astronaut, again utilizing the folding tab, rotates the rigid sealing bar down the bag at least three turns. The ductile wires along the sides of the bag retain the new shape of the bag, and a containment system similar to a labyrinth seal is created. Since this device is meant to be utilized by astronauts wearing EVA suits, ergonomics and safety considerations are heavily emphasized in THANoS'design.

SMARTPHONE SIMULATIONS IN THE ASTRONOMY CLASSROOM

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This presentation will summarize efforts at implementing smartphones in the introductory astronomy classroom. We will briefly summarize our design framework for creating simulations, an example simulation or two (publicly available at https://astro.unl.edu/smartphone), our pedagogical framework for using them in the classroom, and then share anecdotal experiences from the classroom. Snippets of a YouTube series of videos developed with funding from the American Astronomical Society (available on YouTube on the UNL Astronomy channel (https://www.youtube.com/user/AUastronomy) will be included as well as future development plans.

COLLEGE OF SAINT MARY ELEMENTARY OUTREACH PROGRAM 2021-2022

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The College of Saint Mary (CSM) Elementary Outreach Program has been in effect for over 10 years and provides hands on activities and interactive learning in math and science topics to elementary students (grades K-6) in the Omaha and surrounding areas. This service is provided by CSM students who work in groups 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 utilize student volunteers from all majors and backgrounds at CSM. Currently, the Outreach Program houses eight science experiments each, for ages K-2 and 3-6. Due to the ever-changing visitor protocols for COVID, the program was able to be brought back into a few of the area schools. Through March of 2022, a total of 113 students have been served with 83 in grades K-2 and 30 students in grades 3-6. These results came from elementary schools and the Girls, Inc. organization, a non-profit organization. More activities are scheduled for the remaining months of the school year. Since new research has shown an 11-12 percent drop in interest in STEM careers, just in the last year, this 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. Most area elementary schools do not have the resources to incorporate similar activities. The Outreach program allows children to experience projects they can take home and continue researching. CSM student volunteers, from all backgrounds, give positive feedback on their experiences and enjoy the opportunity to volunteer their time to benefit the community. They have the opportunity to experience how these activities are enjoyed by all the children involved. This project is funded by NASA Nebraska.

BUILDING SELF-EFFICACY IN PRE-EDUCATION ELEMENTARY EDUCATION MAJORS

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Studies show that pre-service elementary teachers need to build more confidence in science literacy and teaching science during their teacher education programs for them to effectively teach science knowledge and skills to their students. This study examines the self-efficacy of 35 elementary education majors in a pre-education plan-of-study during their enrollment in a 16-week general education Science course at a metropolitan university in the United States Midwest. Because self-efficacy is influential to student learning, the results of this study may have significant implications for the design of elementary teacher education programs and the support of elementary teachers in teaching science. Quantitative data were collected using the Science Teaching Efficacy Belief Instrument-Preservice (STEBI-B). A quasi-experimental design pre- and post-survey administrations of the STEBI-B was used to test the significance of differences between the pre- and post-surveys across the course. Results indicated statistically significant gains in participants' science self-efficacy beliefs. The study includes implications for pre-service teacher education programs and science teacher education.

AUGMENTING COMPUTER SCIENCE CIRRICULUM USING OFF-THE-SHELF ROBOTICS KITS MAKER PROJECTS TO ENHANCE WHOLE BRAIN AND BALANCED LEARNING

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Computer Science curriculums have traditionally used creating desktop applications as the focus of their learning activities. Off the shelf robotics kits and other maker projects provide a hands-on approach and allows the students to see their "code in motion". The WNCC Computer Science curriculum starts in the first year with Intro to Robotics. This class uses an off the shelf Arduino based robot. This robot can be programmed by a mobile device, Scratch based block environment, and Arduino C. Arduino C is very similar to Java, which makes this a good programming scaffold to Java and C++. This year, we added a more advanced robot, the GoPiGo, to the curriculum. They are currently being used in projects for our NASA fellowships. The Raspberry Pi based GiPiGo can be programmed in multiple languages, Python, C, Java, and others, making the Pi a versatile platform for learning multiple programming languages. Students work with sensors, streaming video, uploading data to the web, Python, and Tkinter for a GUI. The WNCC Computer Science curriculum is being redesigned in collaboration with the University of Nebraska at Lincoln and Southeast Community College through the STEM-CONNECT grant. One of the major focuses is using multiple languages as a scaffolded curriculum. Learning HTML, CSS, JavaScript, SQL, Python, Java, and C++ better prepare students for the diversified software engineering workplace. Using multiple languages brings the students to a higher conceptual level, rather than memorizing the syntax of a specific language. This year we purchased a 3D printer. Our maker project for the spring semester is building Thor, An Open-Source 3D Printable 6DOF Robotic Arm. This project supports learning the skills of 3D printing, soldering electronics on a custom PCB, assembly, and programming the Arduino Mega microcontroller. The plan for next year is to build an open-source Mars rover. This hands-on approach of seeing the results of their code in the physical world enables a faster feedback learning cycle and better transfer and retention of knowledge, skills, and conceptual frameworks. Students enjoy working with the robots and other maker projects in the physical world, having fun enables better learning.

VIRTUAL REALITY FOR PHYSICS EDUCATION: GETTING STARTED

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Learning physics is challenging for many students, especially when the spatial limitations of classrooms and labs cannot accommodate fruitful experiments and demonstrations which are integral to a wholesome understanding of basic physical concepts. This project focuses on developing a malleable virtual reality (VR) framework that assists in physics education for the general physics audience. We hypothesize that an immersive 3-D VR experience will be more effective at developing expert-like mental models, as compared to simulated 3-D and/or static 2-D representations of similar concepts. Using the Unity® game engine, we developed a user-friendly playground where teachers and students can add and interact with a VR environment. For example, the "user" can explore different objects (i.e., a basketball and hoop, a ball on a string, etc.), grab, move, and otherwise and interact with them. The user can also move around the virtual environment via teleporting or direct movement and be impacted by earth-like physics (i.e., gravity, collisions, etc.). In this presentation, we will document the learning curve to starting VR programming as well as the resources, methods, and best practices which aided in the process including numerous online resources such as Circuit Stream, Unity® documentation, and YouTube tutorials. Concepts from those resources were integrated together to create a VR experience that fit the goals of this virtual learning environment. Due to the steep learning curve that accompanies creating VR projects from scratch, the result of this project was to create an initial "sandbox" environment that is scalable and editable for future students to continue development. This project is the first step in creating an efficient, larger application that creates accurate and interactive simulations which parallel the physical world; benefitting future researchers and students who want to go beyond the lab or classroom to work in frontiers that are difficult to replicate. For example, the environment itself could be changed as desired, manipulating gravity, elevation, air density, and/or making a complete change to the environment. For example, performing the simulation underwater or in space.

ENVIROBOT USING RASPBERRY PI BASED ROBOT TO EMULATE A MAR'S ROVER MISSION

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This research project was designed to explore the development of a Mar's Rover autonomous surface vehicle for treacherous and flat surface exploration using the GoPiGo robot kit. This project focuses on three principal areas: navigation, camera, and collecting temperature, humidity, and pressure data. An autonomous navigation program was developed in Python. The robot has a range-finding sensor that can detect an obstacle in its path. The algorithm will detect any obstacles in front of it. The sensor it determines the longest distance between left and right then turns to the longest distance. The GoPiGo has a video camera that will live stream to a website. The video will allow the monitoring the GoPiGo progress. While the robot is using autonomous navigation it uses an environmental sensor that will collect the temperature, humidity, and pressure data. The collected data will live stream to a website. In this project, I have learned many life skills, such as perseverance, and programming experience in Python. To summarize, this project was designed and built to explore and gather data like a Mar's Rover.

WOMEN IN STEM

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Women are constantly underrepresented in STEM occupations (Corbett & Hill, 2015; Hill et al., 2010). In Nebraska, about 27% of women 25 years or older worked in a core STEM occupation (U.S. Census Bureau, 2019). To understand the barriers and opportunities for women in STEM in occupations in Nebraska, this research presents the lived experience of Nebraska's women in STEM following 48 in-depth interviews with women working in STEM occupations in Nebraska. As a result, interviewees shared their passion and interest for entering the STEM professions and described their past and current work environments. Interviewees' stories illuminated several of the most common barriers women in STEM face, including power dynamics especially with male supervisors and colleagues, pursuing advancement and promotion opportunities, and balancing work with family or leisure activities. Importantly, interviewees provided a range of recommendations for how to better support women in STEM at all stages of their career journey, including training and outreach.

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100K EXPERIMENTAL HYBRID ROCKET ENGINE DESIGN TEAM

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100k Experimental Hybrid Rocket Engine Design Team (100k) is designing and building a hybrid rocket O-Class engine intended to be assembled with an airframe and launched to reach a height of one hundred kilometers in the atmosphere. This hybrid rocket will have the potential to deliver aerial experimental payload satellites to orbit. 100k has a sub team for each system of the engine. These sub teams have developed the oxidizing, combustion, and electrical systems, and fuel grains. 100k developed the first model of the engine, Odin I, in 2019. Currently, the design of the second model, Odin II, is undergoing manufacturing and will be assembled this academic year. The second model is an improved and hydrostatic and static fire test-ready engine. Along with the improvements of the engine, improvements of the fuel manufacturing process have been achieved with the addition of reducing air pockets with a vacuum oven and x-ray imagery. In order for the engine to be static fire test-ready, the team plans to conduct a hydrostatic test of the oxidizing system to ensure valves and their ignition and shutdown systems work properly. This will be done by running water through the system at the expected pressures of the nitrous oxide oxidizer. Looking forward, once data is received and analyzed from the hydrostatic test, the team will conduct a static fire of Odin II to observe where improvements are needed for a third model of the engine, Odin III, that has the potential of a low altitude flight.

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

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The International Aerial Robotics Competition, IARC, is a competition based on pushing the edge on Aerial Robotics. Each time their competition is completed, they create a new mission set to be increasingly difficult from the last. The current mission, Mission 9, has an aerial vehicle fly around a 2 km obstacle course, with several moving objects to avoid. After flying through the course, the Aerial vehicle must remove a communication module from a mast and replace it with an identical module. During the entire operation, the mast sways in periodic motion. The vehicle will then fly back through the course and land on the starting platform. For the duration of 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. Using a mixture of computer vision and RTK positioning, the aerial vehicle will be able to autonomously fly through the obstacle course. Once at the mast, the drone will track the movements with a camera. Using two arms, the drone will pull off the existing communication module. Using a third arm, the drone will attach a new module to the mast.

UNIVERSITY OF NEBRASKA-LINCOLN AEROSPACE LUNABOTICS COMPETITION TEAM

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The University of Nebraska-Lincoln Aerospace Lunabotics Competition undergraduate student team competes in the NASA Lunabotics Competition. Each year the team designs, builds, and tests a robotic rover capable of mining for icy regolith underneath a simulated lunar surface which closely resembles the conditions at the lunar South Pole. This is where the Artemis program plans to send rovers ahead of manned missions. NASA hosts this competition annually at the Kennedy Space Center in Florida with 50 teams selected from universities across the country. In April the team will complete a Systems Engineering Paper, a Public Outreach Project Report, and an early April robot proof of life video. All competition deliverables and requirements must be met for the team to compete. This year, the team has grown considerably 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 sub-team has been testing a track system. The design for the excavation subsystem includes a large auger on an actuated platform allowing the robot to mine for regolith much farther below the surface. The material handling subsystem stores the excavated regolith in a scoop hopper until it is ready to be deposited. The hopper is then raised via a string and pulley system to deposit the collected regolith. The electronics subsystem is designed to be dust resistant and modular so individual parts can be more easily disconnected and replaced without disassembling the entire system. The programming sub-team focused on robot control and how the rover operator manipulates each part. Currently, the project is being manufactured and each subsystem on completion is being tested individually. Early testing has been very promising and has already led to functional design improvements. The drivetrain and material handling subsystems have been tested the most extensively, allowing these sub-teams to identify design issues and work to correct them before the competition.

LOW EARTH ORBIT MISSIONS FOR EDUCATION AND RESEARCH

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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 cost-effective way. In a history-making fashion, the Nebraska Big Red Satellite team (NBRS) will be launching the first ever CubeSat from Nebraska! The University of Nebraska-Lincoln's Aerospace eXperimental Payloads (AXP) team has partnered with middle and high school students across the state to form NBRS. NBRS is developing a cubesat for the CSLI, dubbed Big Red Sat-1. NBRS aspires to directly engage students with STEM and gain engineering experience. The 21 middle and high school students on the team have researched, designed, and presented Big Red Sat-1 and its payload. To facilitate a technological demonstration of our CubeSat and perovskites beforehand, we are working on a high-altitude balloon project launching April 23rd of this year. A crucial part of their experience is initiative; the undergraduate AXP team does any advanced technical work and oversees the whole project, but the 7th - 12th grade students have ownership over most of the work. NBRS also has a student leadership team for team president and each of the subsystems of the CubeSat. This allows the students to gain not only technical knowledge, but the soft skills and leadership abilities to succeed in their future careers. 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 small size, weight, and increased flexibility make them a potentially attractive solution for solar arrays both on Earth and in space. We intend to 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. Preliminary research has indicated that they can, but our CubeSat flight will give us clear experimental evidence. By testing the greater power efficiency, sustainable lifetime, and superior light collection of perovskite solar panels, Big Red Sat will demonstrate that perovskite photovoltaics are a promising solution for future space missions.

THE INVESTIGATION AND IMPLEMENTATION OF NANOGALVANIC ALLOYS FOR DEEP SEA AND DEEP SPACE APPLICATIONS

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Little is known about the deepest depths of the ocean; far less is known about what lies beneath the icy shells of ocean worlds in this solar system like Enceladus and Europa. It is a mission of the NASA Jet Propulsion Laboratory to explore terrestrial and extraterrestrial waters. The goal of this project is to contribute to this considerable effort by designing a device that can attach to a submersible. This design should provide the foundation for a device capable of functioning at extreme pressures and low temperatures. An aluminum-based nanogalvanic powder, created by the Army Research Lab, will be employed in the device to generate hydrogen; this special powder has a 100% yield rate when in contact with aqueous liquids. The generation of hydrogen will thus create buoyancy for an emergency beacon attached to a submersible. In the event the submersible falls under distress, the device will detach from the submersible and use the powder to surface. Over the course of ten months, the device will be designed, prototyped, and tested. The design of this device will be completed using analysis and modeling software like MATLAB and Solidworks. The prototype will consist of 3D printed parts with off-the-shelf fasteners and valves. Near the end of this project, the prototype will undergo various modular tests; this will lead up to the final test in a five-foot vessel of water to determine the functionality of the device created.

NITROUS OXIDE PRODUCTION UNDER NITRATE STIMULATED REDUCING CONDITIONS

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A key driver of various geochemical processes on iron-rich, rocky planets, like Mars and Earth, is likely the cycling of iron. Organic matter is also known to be present on both planets suggesting the potential of microbially catalyzed iron cycling on Mars, similar to what has been documented on Earth. Additionally, on Earth, iron cycling has been shown to be intertwined with both carbon and nitrogen cycling. Previous studies have found that influxes of an oxidant, such as nitrate, stimulate the oxidation of reduced chemical species. Sediment for this study was obtained from an oxbow lake and homogenized with a 0.2mm mesh sieve before use. These sediments serve as a parallel of fluvial systems. Preliminary studies showed that influxes of nitrate at low concentration stimulated reducing conditions, suggesting that this process could contribute to the flux of greenhouse gases such as methane and nitrous oxide. As such, I hypothesize that the transient reducing conditions stimulated by nitrate will increase greenhouse production. A series of anoxic batch reactors containing organic-rich iron bearing sediments were amended with bicarbonate buffered aqueous basal medium [pH 6.7] and 20 mM synthetic ferrihydrite. After a brief pre-incubation, batch reactors were spiked with nitrate at a total concentration of 0.3 mM. Samples were periodically collected for the quantification of iron species (Fe(II), total), nitrogen species (nitrate, nitrite, ammonium) and headspace gases, nitrous oxide and methane. Our results show that influxes of nitrate, at low concentrations, stimulate transient reducing conditions as shown by an increase in Fe(II). Along with the increase in Fe(II), there was also an increase in headspace nitrous oxide as determined by gas chromatography. However, there were no observed net changes in gas production of methane. This study describes details of iron cycling that were previously unknown, suggesting for the need to include that an oxidant does not always strictly stimulate reducing conditions in biogeochemical models. The intricacies of these biogeochemical cycles allow us to better understand how microbially catalyzed reactions alter their environment and contribute to our insight into the habitability of iron-rich rocky planets like Earth and Mars.

AN IN VITRO SYNTHESIS OF BACILLITHIOL

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Bacillithiol (BSH) is a low-molecular-weight thiol that plays a variety of roles within Gram-positive bacteria species and is associated with mechanisms involving Fosfomycin resistance. Fosfomycin, a broad-spectrum antibiotic, is used to treat infections such as those caused by methicillin-resistant Staphylococcus aureus (MRSA). The issue of antibiotic resistance has continued to become a greater threat, and the production of new antibiotics has been limited. Utilizing novel drug targets may be useful to combat this issue moving forward. Due to its involvement with Fosfomycin resistance, bacillithiol's biosynthetic pathway is an appealing novel target for future drugs. Bacillithiol is synthesized in a three-step process, where UDP-N-acetylglucosamine (UDP-GlcNAc) is first converted to N-acetylglucosaminyl-malate (GlcNAc-Mal). Following, GlcNAc-Mal is deacetylated to form glucosamine malate (GlcN-Mal). GlcN-Mal is then converted to bacillithiol. The first two steps of the biosynthetic pathway are fairly well understood and are able to be completed in vitro. An in vitro synthesis of the third step of the reaction has been unsuccessful. Mechanisms behind the third step involve the addition of a cysteine residue, which converts GlcN-mal to bacillithiol via catalysis by BshC. This research works towards determining what conditions are necessary for a successful in vitro synthesis of bacillithiol. Isolation of the BshC enzyme was done before reactions were tested. Further data collection of the reactions is currently underway. After isolation of BshC, reactions will be run using a variety of cofactors. Well plates will include cofactors, a buffer solution, BshC, GlcN-mal, and cysteine. After reacting, the products will be derivatized using ninhydrin. Following derivatization, the products will be separated using thin layer chromatography (TLC) and visualized using ninhydrin staining of the amine group.

MONOCLONAL ANTIBODIES IN BREASTMILK OF VACCINATED WOMEN

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Secretory IgA antibodies found in the breastmilk of vaccinated women could provide new ways to deliver medicines. Antibodies provide protection specific to certain pathogens that enter the body. These pathogens can be deadly, but the antibodies attach to the pathogen and help activate the immune system to kill it. With the recent pandemic, the SARS-CoV-2 virus has been a large area of interest among immunologists. The IgA antibodies being studied in this experiment are specific for this virus. The insight brought from this research could help not only infants, but people of all ages survive the virus. During this study, the ELISA method was used to identify the presence of IgA antibodies. Enzymes were added to breastmilk samples and centrifuged in order to isolate the immunological components. The addition of enzymes was also used as a simulation of an infant's digestive system. IgA antibodies have the highest concentration in breastmilk when compared to other types of antibodies. The IgA antibodies are the only type to be detected in the ELISA kit used. The hypothesis of this study is that IgA antibodies against SARS-CoV-2 will be found in the breastmilk of vaccinated women. Sample collecting is still in progress.

Aeronautics & Space Science Chairperson(s): Dr. Scott Tarry & Michaela Lucas

FRIDAY, APRIL 22

AERO POSTER SESSION **Location: Pre-Recorded on YouTube**

WEATHERING DEEP SPACE: OPTIMIZING 5' AMP AND N^6-CYCLOHEXYLADENOSINE TO INDUCE CONTROLLED HYPOMETABOLISM. Eric Bredahl, Nik Johnson, Elizabeth Kettler, David Law, Elizabeth Roberts, Jake Siedlik, Mitchel Magrini, Joan Eckerson FACSM, and Kristen Drescher (abstract) (YouTube Link to Poster)

IRREGULAR METRONOME TRAINING TO ENHANCE SENSORIMOTOR PRECISION. Kolby J Brink, Joel Sommerfeld, and Aaron D. Likens (abstract) (YouTube Link to Poster)

ISOLATION OF IRON OXIDE REDUCING BACTERIA FROM THE *ZEA MAYS* RHIZOSPHERE. Morgan Owen, Jacob Owens, Taylor Rosso, Nicole Fiore, and Karrie Weber (abstract) (YouTube Link to Poster)

REDUCING VIBRATIONS IN HIGH-ASPECT RATIO WINGS USING NONLINEAR VIBRATION ABSORBERS. Judith Brown and Keegan Moore (abstract) (YouTube Link to Poster)

PORTABLE COMPUTERIZED DYNAMIC POSTUROGRAPHY/TRAINING SYSTEM FOR ASTRONAUTS. Farahnaz Fallahtafti, Robert Izuta, Melissa Scott-Pandorf, and Sara Myers (abstract) (YouTube Link to Poster)

SAMPLE CALIBRATION MARKER DESIGN FOR USE DURING LUNAR EXTRAVEHICULAR ACTIVITES AS PART OF THE ARTEMIS PROGRAM. Samuel Harvey, Simon Thengvall, Connor Birkholz, Matthew Bigge, Jose Vazquez, and Carl A. Nelson (abstract) (YouTube Link to Poster)

DESIGN AND CONSTRUCTION OF A HIGH-POWER ROCKET AND A DEAD-RECKONING PAYLOAD. Grant Meyer, Judith Brown, and Phoebe Pena (abstract) (YouTube Link to Poster)

DEVELOPMENT, CHARACTERIZATION, AND STABILITY EVALUATION: LIPID-BASED FORMULATIONS OF POLYPHENOL COMBINATIONS. Emily Gilbert and Dr. Dunesh Kumari (abstract) (YouTube Link to Poster)

WEATHERING DEEP SPACE: OPTIMIZING 5' AMP AND N^6-CYCLOHEXYLADENOSINE TO INDUCE CONTROLLED HYPOMETABOLISM

Eric Bredahl[1], Nik Johnson[1], Elizabeth Kettler[1], David Law[1], Elizabeth Roberts[1], Jake Siedlik[1], Mitchel Magrini[1], Joan Eckerson FACSM[1], Kristen Drescher[2], ecb65167@creighton.edu

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Overcoming microgravity-induced atrophy and tissue wasting is key for long-term survival and preservation of functional capacity. One such approach, is to slow the enzymatic processes that underly muscle atrophy. Altering the activity of adenosine receptors can create a system-wide change towards hypometabolism, thus slowing metabolic and enzymatic activity. Purpose: To characterize and identify the optimal dose of 5' adenosine monophosphate (5AMP) and N^6-cyclohexladenosine (CHA) to induce a state of artificial metabolic depression. Methods: L6 skeletal muscle myoblasts, C2C12 cardiac myoblasts, HEK 293 human embryonic kidney, hFOB human osteoblasts, NT2 testis cells were cultured in growth medium (90% DMEM 10% FBS) until they reached 90-95% confluency. Cells were then seeded onto a 96-well plate at a density of 10,000 cells/ml with fresh growth media and incubated for 24 hr prior to experimentation. Cells were then exposed to growth media containing either CHA (10mM-100µM) or 5AMP (1M-30mM) at varying doses. Cell viability was assessed immediately after incubation via a Nikon live cell confocal imaging system. Oxygen consumption and glycolytic activity were assessed using ELISA based assays. Results: Both 5AMP (<125 µM) and CHA (<12.5 µM) reduced metabolic activity by 15% and 20% respectively. Furthermore, at the respective doses, there was no significant change in cell viability relative to control cells ($P>0.05$). Conclusion: Initial evidence suggests that a low dose of CHA and 5AMP can create a moderate degree of metabolic depression.

IRREGULAR METRONOME TRAINING TO ENHANCE SENSORIMOTOR PRECISION

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Numerous studies spanning the last two decades have shown that healthy biological signals (e.g., heart rate, gait parameters, reaction times) exhibit a complex time series structure portraying statistical long-range correlations such that size of movements (e.g., steps, arm swings) tend to be related over time. Those findings confer that movements exhibiting long-range correlations enhance coordination among physiological processes, leading to an optimal functional state. Synchronizing movements to an irregular metronome structured with long-range correlations restores complexity in several populations (e.g., older adults, Parkinson's, and Huntington's populations). Irregular metronomes also promote resilience to mechanical disturbances, suggesting that an optimal state of complexity may also enhance sensorimotor efficacy. Our aim is to observe whether training movements to exhibit a complex structure during a generalized task will improve sensorimotor coordination. 51 healthy adults will perform a pre- and post-Sensorimotor Task (ST) as well as a training task. Subjects will perform a pre-ST of tapping alternately between two rectangular target plates as quickly and accurately as possible. The amplitudes and widths of the targets will be randomized with 16 different combinations, changing the index of difficulty of the task. The dependent variables will be average movement time between targets and error percentage. Subjects will then be randomly placed in one of three groups which will dictate whether they receive training and if so, what type of training they will receive. Subjects in Group 1 and 2 will undergo 4 sessions of training over a 2-week time span following the pre-ST. During training, subjects will be seated and perform wrist rotations in a chair with modified arm rests which have attached manipulanda. Group 1 will perform continuous wrist rotations synchronized to an intermittent metronome lasting 30 minutes. Group 2 will perform wrist rotations at a self-selected pace with no metronome for 30 minutes. After the training sessions are completed, Groups 1 and 2 will complete a post-ST. Group 3 will perform a pre- and post- ST with no training. We expect Group 1 to exhibit a greater decrease in error percentage and average movement time on the post-ST compared to the other groups. Group 1's training will require subjects to adopt an optimal state of movement, which we hypothesize will enhance sensorimotor performance. Groups 2 and 3 are expected to have a slight decrease in error percentage and average movement time due to experience gained from the pre-ST.

ISOLATION OF IRON OXIDE REDUCING BACTERIA FROM THE *ZEA MAYS* RHIZOSPHERE

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Mars is an iron-rich rocky planet bearing various iron oxide (Fe(III)) minerals. Iron oxide minerals can provide a source of nutrients as well as an electron acceptor for microbial respiration. Thus, the surface and subsurface of Mars has the potential to support microbial life. Given that iron is the 4th most abundant element in the Earth's crust, thus allowing us to use processes on Earth as an analogue for investigations of the metabolic potential of Martian microbial life. This study aims to identify such iron respiring microbes from soil samples collected from a soil environment surrounding plant roots where there are inputs of carbon that drives redox cycling, rhizosphere. The rhizosphere is the soil that surrounds and is influenced by the roots of a plant. Rhizosphere soil was collected from *Zea mays* and added to anoxic (80:20; Ar:CO_2 atmosphere) culture medium amended with simulated root exudates (i.e., sugars and amino acids) and an iron oxide source, solid-phase synthetic hydrous ferric iron oxide or soluble iron oxide chelated with nitrilotriacetic acid (Fe(III)-NTA). These samples incubated for four weeks until visible iron oxide reduction was observed. Following visible iron reduction cultures were transferred six times before colony isolation yielding isolation of six colonies. DNA was extracted from each pure culture for taxonomic identification of the isolate. The isolates were either capable of reducing Fe(III)-NTA, Fe(III)-citrate, or Fe(III)-pyrophosphate. The identification and characterization of an iron-reducing bacterium from this environment demonstrates that iron reducing bacteria persist in the rhizosphere and have the potential to liberate iron through the reduction of Fe(III) oxides to soluble and biologically available Fe(II). Iron reduction could be beneficial to the ambitious concept of terraforming on other iron-rich rocky planets. The reduction of iron-rich soils including those on the surface of Mars would release macro nutrients (i.e., phosphorus) and micronutrients (i.e., biologically available iron) enabling crop production.

REDUCING VIBRATIONS IN HIGH-ASPECT RATIO WINGS USING NONLINEAR VIBRATION ABSORBERS

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The implementation of high-aspect ratio (HAR) airplane wings can substantially improve the aerodynamic performance of jetliners while lowering fuel consumption. However, the low natural frequencies of HAR wings result in high-amplitude vibrations that occur in multiple directions simultaneously. These vibrations can prove detrimental to the airplane. This research studies vibration mitigation in HAR wings using multi-directional nonlinear vibration absorbers (NVAs). A full-model airplane, consisting of two wings and a fuselage, has been constructed to simulate the response of a jetliner with HAR wings. This model has been evaluated computationally and experimentally to ensure that it matches the behavior of a real HAR airplane. A finite element model that mimics the natural frequencies of the model airplane has been constructed. A computational study was conducted to determine the dynamics of the model HAR airplane plane under four separate conditions: when no NVAs are installed, only one NVA is installed on the left wing, only one NVA is installed on the right wing, and when one NVA is installed on each wing for a total of two absorbers. The results of the computational study demonstrate that all configurations with NVAs are effective at mitigating the vibrations of the HAR wings.

PORTABLE COMPUTERIZED DYNAMIC POSTUROGRAPHY/TRAINING SYSTEM FOR ASTRONAUTS

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An astronaut's sense of balance and body orientation takes time to re-adapt to normal gravitational conditions. Advancement of technology to assess posturography can identify functional limitations in astronauts caused by sensory, motor, and central adaptation impairments that interfere with normal balance and mobility. Currently, accurate assessment of balance can only be performed with expensive and stationary laboratory equipment. To address the existing limitations, the focus of this project was to define specifications for a portable computerized dynamic posturography and balance training system, called Lokahi, that could be used for balance assessment and rehabilitation. The specific goals of this project were to first define specifications for the device that must be met to deliver physical perturbations used in sensory organization and motor control tests for clinical/research settings. Therefore, this project focused on developing a computer aided design model and a physical prototype of the proposed portable computerized dynamic posturography and balance training system. We also focused on exploring NASA use-cases for Lokahi by leveraging existing NASA collaborations. In the first phase, two parallel development efforts were being pursued. One effort was to produce a scaled version of Lokahi to develop the motion control algorithms. These algorithms were developed to facilitate the sway of referenced support platform for the sensory organization tests. Expected outcomes of this effort are single-axis control to perform the standard sensory organization test, dual-axis control for development of new sensory organization tests, varying levels of tilt instability(resistance), and the ability to respond to inputs from the user and perturb the user to test balance responses and facilitate training and rehabilitation. The second effort was to develop a test platform capable of incorporating a force plate and supporting the weight of an adult. This platform initially could not have digital motion control but will use physical mechanisms to control the range of tilt and the level of instability. The outcomes of this effort were to assess and compare the different proposed methodologies to determine the center of pressure and center of mass using existing techniques such as a force-platform, inertial measurement units, and pressure insoles. The two development efforts are in process to converge into a single design to pursue further research and development and incorporate virtual reality for the visual sway reference. The proposed design will be affordable and portable to deliver more effective, evidenced-based rehabilitation for astronauts with vestibular and musculoskeletal dysfunction post space mission.

SAMPLE CALIBRATION MARKER DESIGN FOR USE DURING LUNAR EXTRAVEHICULAR ACTIVITES AS PART OF THE ARTEMIS PROGRAM

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As part of the Artemis program, astronauts will document and collect samples from the lunar surface. One crucial part of the documentation process is taking photographs of potential samples before collection and sending them back to scientists on Earth. In order to determine the color, reflectivity, and size of each sample, a sample marker with known properties is placed next to each potential sample. This data is used to determine which samples to collect and return to Earth. After the samples to collect are determined, the astronauts refer to reference codes on the sample markers to find and retrieve the relevant samples. Previous lunar missions used tripod style markers that cast a shadow in order to calibrate the location as well as color and size, but advances in location technology have rendered these no longer necessary. There is now a need for a new and improved sample marker design. The new sample marker design must be able to stay in place on the lunar surface, be able to be seen from a variety of angles and be able to be deployed without requiring the astronaut to bend at the knee. This sample marker design consists of a bent sheet metal pyramid approximately 1.5” tall with a base of 4” by 5”. Each of the two longer slopes has an alphanumeric label (such as ‘A1’) and six colored squares (red, blue, green, black, grey, and white). These labels can be seen from directly from the side, at an angle, or from directly above the marker. Each sample marker also has a small round stud extending from the top to connect with a deployment tool. The deployment tool is an extendable pole with a lever handle (similar to a bike brake) on one end and a grabber head on the other. The tool can be pushed down on top of the sample marker and springs within the grabber head will latch onto the marker. The handle on the tool can later be pulled to extend a piston within the grabber head and eject the sample marker. The deployment tool will allow an astronaut to quickly and easily deploy and retrieve multiple sample markers without bending down.

DESIGN AND CONSTRUCTION OF A HIGH-POWER ROCKET AND A DEAD-RECKONING PAYLOAD

Grant Meyer[1], Judith Brown[1], Phoebe Pena[2], gmeyer7@huskers.unl.edu

1 - Department of Mechanical and Materials Engineering, University of Nebraska-Lincoln, NE.

2 - School of Biological Sciences, University of Nebraska-Lincoln, NE.

As part of the UNL Aerospace Club, team Husker Rocketry annually designs, constructs, and flies high-power rockets for a competition of its choosing. This year, the UNL Husker Rocketry team is participating in the Spaceport America Cup competition. The rocket, named Hydrus, is approximately 9 ft. long and has a 6 in. diameter. It will be powered by a commercially produced motor to reach a target altitude of 10,000 ft. Design and modeling of the rocket used the flight simulator software OpenRocket. This software helped define the optimal dimensions and motor for the rocket to achieve the 10,000 ft altitude goal while avoiding speeds too close to Mach 1 (at which airflow dynamics become highly irregular and more difficult to ensure safe rocket flight). Flight simulations predict an altitude of 10,500 ft and a maximum velocity of 676 miles per hour. Our payload this year is designed to eject at the same time as the drogue and then locate the main body of the rocket using dead reckoning instead of using a Global Positioning System (GPS). Dead reckoning combines measurements from three sources (accelerometers, gyroscopes, and magnetometers) to determine how far the payload has moved from the rocket. This data will be transmitted to the team so we can locate both the payload and the main rocket body. A backup GPS system will be in place to ensure the location of the rocket. The parts for the rocket are commercialized off-the-shelf items from various rocketry component retailers.

DEVELOPMENT, CHARACTERIZATION, AND STABILITY EVALUATION: LIPID-BASED FORMULATIONS OF POLYPHENOL COMBINATIONS

Emily Gilbert[1], Dr. Dunesh Kumari[1], egilbert0586@csm.edu
1 - Department of Chemistry, College of Saint Mary, Omaha, NE.

Polyphenolic compounds such as curcumin and quercetin are naturally occurring antioxidants that inhibit free radicals, reduce superoxide anions and peroxides, and inhibit low-density lipoprotein oxidation and lipid peroxidation. Preliminary studies have shown that these compounds can be used to treat and prevent chronic conditions such as cancer and type II diabetes, but their activities are limited due to their poor solubilities resulting in low oral bioavailability. This makes it difficult for either compound to reach active sites outside of the gastrointestinal tract. While it is difficult to increase the solubility of either drug on its own, it is increasingly more difficult to simultaneously increase the solubility of both compounds. However, once achieved, the combined formulation will provide the additive/synergistic advantages associated with their respective activities. Novel lipid formulations of curcumin-quercetin and their combinations using various excipients such as polyethylene glycol and surfactants were prepared using high sheer homogenization and ultrasonication. Lipid formulations were characterized by particle size and zeta potential; UV-spectroscopic methodology was used for the simultaneous detection of curcumin and quercetin in the developed lipid formulations. Long term stability of these formulations has been evaluated over three months with storage at 4°C. Further, the in-vitro release of curcumin and quercetin will be carried out with Slide-A-Lyzer Dialysis Cassettes and skin penetration studies will be conducted using Franz diffusion cells. Overall, curcumin-quercetin loaded lipid nanoparticles were successfully formulated with average lipid nanoparticle size of 200-300 nm. Preliminary results have shown increased solubility and long-term stability of the polyphenolic compounds. These formulations will be further utilized for in-vitro and in-vivo testing against melanoma cell lines. Samples for particle analysis were prepared by diluting 100 µL of the emulsions with 2 mL of deionized water. Zeta potential analysis was done by diluting 100 µL of the emulsions with 5 mL of deionized water. A zeta potential analyzer was used to analyze the particle size and zeta potential of the resultant emulsion lipid formulations; this has shown an average particle size ranging from 200 to 300 nm. Curcumin (123 $\pm$ 1.23 nm) and quercetin lipid formulations (113 $\pm$ 5.64 nm) have shown reduced particle size when compared to drug combination loaded lipid formulations.

ANTHROPOLOGY SECTION Chairperson: **Dr. Taylor Livingston**

FRIDAY, APRIL 22 **Location: 218 Acklie Hall**

MORNING SESSION - 1

7:30 Presenters upload talks from USB drives onto the room computer desktop.

7:45 ZOOM Session opens for participants to join https://unl.zoom.us/j/96302784923

If you need assistance connecting via Zoom, or finding the right session, please contact UNL's CSMCE Home Room Support team

8:00 AN OBSERVATIONAL STUDY OF DOMESTIC PIG (SUS SCROFA DOMESTICUS) DECOMPOSITION IN THE GREAT PLAINS, USA DURING FALL AND WINTER. Bri Petersen, Jenna Alexander, Dzemila Arap-Ward, Ella Axelrod, Patrick Barchett, Finn Kennison, Gabrielle Mace, Mason McKinney, and Andrea Sbei (abstract)

9:30 **BREAK**

11:00-12:00 **MAIBEN LECTURE** **Olin Hall Lecture Hall 'B'**
https://unl.zoom.us/j/9289316099

Dan Sitzman, Lecture Title: *History of the Nebraska Academy of Sciences*

12:00-12:30 **BUSINESS MEETING Olin Hall Lecture Hall 'B'**
https://unl.zoom.us/j/9289316099
Nebraska Academy of Sciences (all members)
State of the Academy
Awards Ceremony
Comments from Members-at-Large

12:30 – 1:30 **LUNCH** Student Center Cafeteria (pre-purchase ticket or pay-at-door)

1:00 – 1:20 ***NAS Future Leaders Panel*** in the **Sunflower Room** (Student Center by the Cafeteria) join the informal discussion to learn how you can help lead NAS into the future

AFTERNOON SESSION – 4

1:30 3:15 **BREAK** Presenters upload talks from USB drives onto the room computer desktop

3:25 p.m. ZOOM Session is open for participants to join https://unl.zoom.us/j/96302784923

3:30 SIGNIFICANCE OF *GIGANTOPITHECUS BLACKII* DENTAL MORPHOLOGY TO THE EVOLUTION OF DENTAL MORPHOLOGY IN *HOMO SAPIENS.* Wren Shawhan (abstract)

3:45 AN ANALYSIS OF ARTIFACTS FROM RELLER PRAIRIE FIELD STATION WITH ARCHAEOLOGICAL SPATIAL CONTEXTUALIZATION. Samuel

Thomas and Dr. Phil Geib (abstract)

5:00 – 7:00 **SOCIAL EVENT** at **LUX Center for the Arts**
Meet with colleagues, make connections, socialize; snacks and soft-drinks, and a cash-donation bar 2601 N. 48th Street, two blocks away https://www.luxcenter.org/

AN OBSERVATIONAL STUDY OF DOMESTIC PIG (*SUS SCROFA DOMESTICUS*) DECOMPOSITION IN THE GREAT PLAINS, USA DURING FALL AND WINTER

Alexander, J.[1], Arap-Ward, D.[1], Axelrod, E.[1], Barchett, P.[1], Kennison, F.[1], Mace, G.[1], McKinney, M.[1], Petersen, B.[1], Sbei, A.[1],
1 - Department of Anthropology, University of Nebraska-Lincoln, NE.

When attempting to estimate the postmortem interval (PMI) of human remains, it is important to have region-specific data related to the taphonomic processes (processes affecting remains from the time of death) a cadaver may undergo. Forensic anthropologists often use domestic pig specimens (*Sus scrofa domesticus*) as a replacement for human remains due to similar skin, muscle type, and hair volume. The postmortem decomposition and taphonomic patterns displayed by these specimens are well documented in many regions but have yet to be explored within the Great Plains. Utilizing a domestic pig specimen at the University of Nebraska-Lincoln's Reller Prairie Biological Station, we examined the early stages of decomposition. Fluctuating between mid 70°s (F), freezing, and below-freezing temperatures, the domestic pig specimen's decomposition rate closely followed patterns observed in cold weather climates (Komar, 1998; Meyer, *et al.,* 2013; Micozzi, 1986). Using the Megyesi *et al.* (2005) scoring system, after 33 days of exposure total body scores ranged from 3 to 17.5 with a mean of 10.8. The Megyesi *et al.* (2005) regression formula was used to calculate accumulated degree days, but the result of this equation was extremely inaccurate when compared to the actual accumulated degree days, similar to other studies (Wescott, 2018). This presentation will discuss these finds as well as the other significant taphonomic processes recorded.

SIGNIFICANCE OF *GIGANTOPITHECUS BLACKII* DENTAL MORPHOLOGY TO THE EVOLUTION OF DENTAL MORPHOLOGY IN *HOMO SAPIENS*

Wren Shawhan cshawhan2@huskers.unl.edu
1 - Department of Anthropology, University of Nebraska-Lincoln, Lincoln, NE.

Only the teeth and jaw of *Gigantopithecus blackii* (extinct genus of ape) have been discovered. However, information can be learned from even these fragments of remains. This massive primate is not an ancestor of *Homo sapiens but* analyzing the similar progression of these two species' dental morphology creates a better understanding of why the current dental morphology of *H. sapiens* persisted in evolution. This presentation will briefly situate *G. blackii* in biological anthropology and its place in the phylogenetic tree of hominids, the similarities, and differences between the dental morphology of *G. blackii* and *H. sapiens*, and finally, the relevance of this information and its contribution to further research in human evolution.

AN ANALYSIS OF ARTIFACTS FROM RELLER PRARIE FIELD STATION WITH ARCHAEOLOGICAL SPATIAL CONTEXTUALIZATION

Samuel Thomas[1], Phil Geib[1], thomas.samuel@huskers.unl.edu

1 – Department of Anthropology , University of Nebraska-Lincoln, Lincoln, NE

Reller Prairie Field station, located about 20 miles south of the University of Nebraska—Lincoln's (UNL) City Campus, is a biological field station belonging to the University, and shares as a site for campus wide research projects. In the summer of 2021, an archaeological field school was conducted under the supervision of Dr. Phil Geib of the School of Global Integrative Studies at UNL. During this field school, students and faculty uncovered a range of prehistoric artifacts from the site and learned archaeological mapping and excavating techniques. Artifacts from Reller Prairie included various types of flakes and stone tools including projectile points and hammerstones. The following two semesters after the dig, data were gathered on various flakes (debris from making stone tools), fire cracked rock, and stone tools to contextualize and analyze finds from the site. As well as documenting finds from the site, mapping data is presented showing spatial relationships of finds and topography of the site collected using a Total Station. In this presentation, data collected are presented and used to map spatial relationships of artifacts in order to better contextualize finds from Reller Prairie. Spatial information from mapping data is used to allocate proper distribution and overall count of flakes, stone tools, and fire cracked rock at the Reller Prairie site. It is with these data and subsequent spatial relationships of various types of prehistoric artifacts that a complete report of excavations of Reller Prairie in the Summer of 2021 is presented for future use and as a record of excavations undertaken.

APPLIED SCIENCE & TECHNOLOGY SECTION Chairperson: **Mary Ettel**

FRIDAY, APRIL 22 **Location: 218 Acklie Hall**

MORNING SESSION – 2: Presentations/Posters

9:30 Presenters upload talks from USB drives onto the room computer desktop.

9:40 ZOOM Session opens for participants to join https://wsc.zoom.us/j/96832933249

If you need assistance connecting via Zoom, or finding the right session, please contact UNL's CSMCE Home Room Support team

9:45 Welcome - Mary Ettel

9:50 ECONOMIC AND INPUT-USE EFFICIENCY IMPACTS OF NITROGEN MANAGEMENT TECHNIQUES IN NON-IRRIGATED MAIZE PRODUCTION. Katie Bathke and Joe Luck (abstract)

10:05 UTILIZING YEARLING WEIGHT (YW) AND HEIFER PREGNANCY (HP) EXPECTED PROGENY DIFFERENCES (EPDS) FOR FERTILITY SELECTION IN BEEF HEIFERS. Beau Jersild and Ann Buchmann (abstract)

10:20 GUARANTEED MEMORY SAFETY IN SPACEFLIGHT. Eli Blaney and Catherine Baker (abstract) poster

10:35 MARS ROVER SUMULATOR WITH OFF-THE-SHELF ROBOTICS KITS. Shelby James (abstract) poster

11:00-12:00 **MAIBEN LECTURE Olin Hall Lecture Hall 'B'**
https://unl.zoom.us/j/9289316099

Dan Sitzman, Lecture Title: *History of the Nebraska Academy of Sciences*

12:00-12:30 **BUSINESS MEETING Olin Hall Lecture Hall 'B'**
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Nebraska Academy of Sciences (all members)
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Comments from Members-at-Large

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https://www.luxcenter.org/

ECONOMIC AND INPUT-USE EFFICIENCY IMPACTS OF NITROGEN MANAGEMENT TECHNIQUES IN NON-IRRIGATED MAIZE PRODUCTION

Katie Bathke[1], Joe Luck[1], kbathke3@huskers.unl.edu of presenting author,

1- Department of Biological Systems Engineering, University of Nebraska-Lincoln, Lincoln, NE.

The efficiency of nitrogen (N) management has become a main concern in agricultural cropping systems for understanding the optimal N rate to help producers improve economically and reduce the exhaustion of the natural resources environmentally. Nitrogen rates vary both temporally and spatially by the interactions of the soil environment and rainfall through a growing season. Thus, a site-specific approach can further optimize this variability with the performance of active canopy crop sensors in relation to crop stress. The objective of this study was to evaluate the performance of active crop canopy sensors for the improvement of N management in a non-irrigated site. The experimental design was arranged in a randomized complete block design including the following treatments of application: grower, sensor-based, NH_3 (100, 140, 180, 220 lb-N/acre), side-dress (24, 63, 100, 140 lb-N/acre), and a zero-control strip. Equipment (i.e., precision ag) data of target nitrogen rate, applied nitrogen rates, and yield data were collected for further analysis of the relationship occurring between total N applied and yield per treatment plan. Data of NDRE reflectance measurements were also collected throughout the growing season to then be converted to geospatial imagery for analysis of crop stress, temporally and spatially throughout the field. Based on the Nitrogen Use Efficiency (NUE) the active sensor management treatment based approach had a better average efficiency (0.558 NUE < 0.683 NUE) with a corresponding increase in Partial Profit Factor (PFP) (100.749 > 8.2035) when compared to grower management application. These results indicate the opportunity for high levels of crop productivity coupled with efficient N management under non-irrigated cropping systems.

UTILIZING YEARLING WEIGHT (YW) AND HEIFER PREGNANCY (HP) EXPECTED PROGENY DIFFERENCES (EPDS) FOR FERTILITY SELECTION IN BEEF HEIFERS

Beau Jersild[1], Ann Buchmann-Coauthor[1], beau.jersild@eagles.csc.edu of presenting author

1 - Department of Biology, Chadron State College, Chadron, NE.

Cattle fertility is an economically relevant trait that is essential to select for. Effects of cattle fertility are witnessed across many levels from the producer to the consumer. Selection for fertility can potentially be achieved using genomic-enhanced expected progeny differences (EPDs). Formulation of EPDs is achieved through the best linear unbiased prediction (BLUP) procedure that utilizes single nucleotide polymorphisms (SNPs), pedigree, phenotype measurements, and progeny performance data. For this study, we focused on the Angus breed due to the amount of genomic data available. The results were based on EPD data from 400 Angus sires. The yearling weight (YW) and heifer pregnancy (HP) EPDs were examined to determine if a relationship existed between the two. Puberty in heifers occurs when they reach approximately 60 percent of their mature weight. The role that early growth has in heifer puberty is apparent and selection for higher growth may lead to gains in heifer fertility. Thus, we suspected that higher YW heifers will reach puberty earlier expressing a higher HP value. Data analysis indicates that selection for higher YW does not significantly ($P = .09$) increase HP. However, selection for high HP is associated ($P < .01$) with increased YW. Traits outside of YW must notably influence HP. Future studies should examine additional EPDs that affect HP. From this study, we found that selecting cattle for HP will result in increased YW over time, but YW selection does not significantly influence HP.

GUARANTEED MEMORY SAFETY IN SPACEFLIGHT

Eli Blaney[1], Catherine Baker[1], eliblaney@creighton.edu of presenting author
1 - Department of Computer Science, Design & Journalism, Creighton University, Omaha, NE.

Unsafe programming languages like C and C++ can lead to undesirable and unpredictable issues concerning computer memory. Programs must use memory safely, and even small errors accumulate to larger problems. For NASA, memory safety is critical so that complex software in spaceflight applications and embedded systems are always functional. While programming languages that safely handle memory exist, many are too inefficient to meet the demands of intensive applications. However, the recently developed language Rust seeks to address memory safety while maintaining performance equivalent to that of C/C++, making it a formidable rival to other system languages. To assess the viability of Rust's borrow-checking for embedded systems and spaceflight applications, NASA's popular F' ("F-prime") software will be implemented in Rust, giving a fair comparison of each implementation's performance. In doing so, Rust may become a viable alternative that is safer, quicker to develop, and more reliable.

MARS ROVER SUMULATOR WITH OFF THE SHELF ROBOTICS KITS

Shelby James [1], Jamess13@wncc.edu of presenting author
1 - Western Nebraska Community College, Scottsbluff, NE.

I have programmed a GoPiGo to gather data about the local area using the programing language Python. The programs were designed to gather picture/video, temperature, pressure and humidity readings. The data will then be uploaded to ThinkSpeak for analysis of the data. This information will then be compiled in an easily viewed format.

BIOLOGICAL SCIENCES SECTION Chairperson: **Therese McGinn**

FRIDAY, APRIL 22 **Location: Room 112 Olin Hall**

MORNING SESSION - 1

7:30 Presenters upload talks from USB drives onto the room computer desktop.

7:45 ZOOM Session opens for participants to join https://nebrwesleyan.zoom.us/j/4783367648

If you need assistance connecting via Zoom, or finding the right session, please contact UNL's CSMCE Home Room Support team

8:00 MAGGOTS ON DRUGS: DRUG INGESTION AND ITS EFFECT ON MAGGOT BEHAVIOR. Evelyn Carreto and Amanda Roe, Ph.D. (abstract)

8:15 DOES KNOCKING OUT THE IMMUNITY REPRESSOR IN A LYSOGENIC BACTERIOPHAGE CAUSE THE PHAGE TO INFECT LYTICLY? Maddy Sladky and Dr. Erin Doyle (abstract)

8:30 IMPACT OF LOCAL TEMPERATURE APPLICATION ON SKELETAL MUSCLE MARKERS OF PROTEOLYSIS AND MYOGENESIS. Mark McGlynn, Monica Kwon, Larry Robins, Liz Pekas, Christopher Collins, and Dustin Slivka (abstract)

8:45 A STUDY OF THE RELATIONSHIP BETWEEN OCTAMERIZATION AND ACTIVITY OF 5-AMINOLEVULINIC ACID DEHYDRATASE FROM ESCHERICHIA COLI. Alethia Henderson, Kalynn Doehling, and Frank Kovacs (abstract)

9:00 THE EFFECTS OF HRCC TYPE III SECRETION PILI ON BACTERIOPHAGE ATTACHMENT. Katelyn Jindra and Erin Doyle (abstract)

9:15 COMPARATIVE ANALYSIS OF THE GUT MICROBIOME OF DOMESTICATED HORSES. Sierra Athen and John Kyndt (abstract)

9:30 **BREAK**
During break - Presenters upload talks from USB drives onto the room computer desktop.

MORNING SESSION - 2

9:40 ZOOM Session opens for participants to join https://nebrwesleyan.zoom.us/j/4783367648

9:45 SATB1 HOMODIMERIZATION IS MEDIATED BY THE ULD DOMAIN INDEPENDENTLY OF DNA. Kade Wehr (abstract)

10:00 INVESTIGATION OF BACTERIOPHAGE SUSCEPTIBILITY AND ANTIBIOTIC RESISTANCE IN *STAPHYLOCOCCUS EPIDERMIDIS* ISOLATES FROM HUMAN SKIN. Ashley Marsh and Dane Bowder (abstract)

10:15 PREVALENCE OF BACTERIAL PATHOGENS IN EASTERN NEBRASKA TICK POPULATIONS. Kaelinn Friesen and Julie Shaffer (abstract)

10:30 YELLOW IS FOR BEETLES, BUT BLUE IS FOR BEES: DIFFERENTIAL SAMPLING USING POLLINATOR VANE TRAPS. Curtis Lin and Theodore Burk (abstract)

10:45 CHEMICAL ATTRACTION OF TICKS (PARASITIFORMIS: IXODIDAE) TO DECOMPOSITION VOLATILE ORGANIC CHEMICALS. Gwyneth Sinclair and Amanda Roe (abstract)

11:00-12:00 **MAIBEN LECTURE** **Olin Hall Lecture Hall 'B'**
https://unl.zoom.us/j/9289316099

Dan Sitzman, Lecture Title: *History of the Nebraska Academy of Sciences*

12:00-12:30 **BUSINESS MEETING** **Olin Hall Lecture Hall 'B'**
https://unl.zoom.us/j/9289316099
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12:30 – 1:30 **LUNCH** Student Center Cafeteria (pre-purchase ticket or pay-at-door)

1:00 – 1:20 ***NAS Future Leaders Panel*** in the **Sunflower Room** (Student Center by the Cafeteria) join the informal discussion to learn how you can help lead NAS into the future

AFTERNOON SESSION - 3

1:15 Presenters upload talks from USB drives onto room computer desktop

1:25 ZOOM Session open for participants https://nebrwesleyan.zoom.us/j/4783367648

1:30 CHARACTERIZING HIGH PERSISTER PHENOTYPES IN *STAPHYLOCOCCUS EPIDERMIDIS* CLINICAL ISOLATES
Mariam Garcia, Kaitlyn Pineda, and Austin Nuxoll (abstract)

1:45 ANTS ALTER EASTERN BLUEBIRD NESTLING CYCLES: FLEDGLING DIFFERENCES BETWEEN TWO POPULATIONS. Jacob Plugge, Elizabeth Hamilton, and Lauren Gillespie (abstract)

2:00 AGGRESSION AND TESTOSTERONE ARE A PROXY FOR CLUTCH SIZE FOR MALE EASTERN BLUEBIRDS. Rachel Otten, Abigail Hornaman, Julia Davidchik, Therese Yates, and Lauren Gillespie (abstract)

2:15 TRANSCRIPTOMICS ANALYSIS OF CANDIDATE GENES IN S. VITTATUM FOR ACCURATE LOCAL TRANSMISSION RATES OF RIVER BLINDNESS. Kevin Popp, Charles Brockhouse, Alexie Papanicolaou (abstract)

2:30 SATB1 FORMS HETERODIMERS WITH SATB2 IN A DNA-INDEPENDENT MANNER. Reagan Petersen and Brett Schofield (abstract)

2:45 EFFECT OF ANDROGEN RECEPTOR ON SCENT MARKING BEHAVIOR IN MICE. Terrell Garraway and Nicholas Hobbs (abstract)

5:00 – 7:00 **SOCIAL EVENT** at **LUX Center for the Arts**
Meet with colleagues, make connections, socialize; snacks and soft-drinks, and a cash-donation bar 2601 N. 48th Street, two blocks away https://www.luxcenter.org/

POSTER SESSION
Smith Curtis Great Hall - Main Level

BIO-1 THE INFLUENCE OF TOPICAL MENTHOL GEL ON THERMOREGULATORY AND PERCEPTUAL OUTCOMES DURING EXERCISE WITHIN THE HEAT. Matthias Walters, Mark McGlynn, Alejandro Rosales, Chris Collins, Marie Powers, Monica Kwon, Larry Robbins and Dustin Slivka (abstract)

BIO-2 FEMALES HAVE MORE TO LOSE; EASTERN BLUEBIRD FEMALES SHOW GREATER NEST DEFENSE THAN MALES AT AN URBAN GOLF COURSE. Ashley Brown, Hali Eddy and Lauren Gillespie (abstract)

BIO-3 I GOT IT FROM MAMA: EXPLORING THE TRANS-GENERATIONAL EFFECTS LONG-TERM PARASITIC INFECTION HAS ON OFFSPRING. Disha Chandra (abstract)

BIO-4 EFFECT OF AGE AND FOOD DEPRIVATION ON ANXIETY-LIKE BEHAVIOR IN MICE. Marissa Baker (abstract)

BIO-5 TEMPORAL GENE EXPRESSION ANALYSIS OF UNO-SLW2 INFECTION OF PSEUDOMONAS FLUORESCENS USING BIOINFORMATICS METHODOLOGIES. Lavanya Uppala, Lydia Phillips, Dr. William Tapprich (abstract)

BIO-6 REMOTE DETECTION OF MACRHYBOPSIS STORERIANA USING EDNA MARKERS. Caroline Feig and Sarah Gaughan (abstract)

BIO-7 IMPORTANCE OF ANTHOCYANIN EXPRESSION IN THE COLORLESS LIATRIS PUNCTATA WITHIN THE PRIMER/ENZYME PATHWAYS. Megan McGuire (abstract)

BIO-8 CHARACTERIZATION OF THE K. LACTIS SPINDLE POLE BODY. Zachary Rinke and Ann Cavanaugh (abstract)

MAGGOTS ON DRUGS: DRUG INGESTION AND ITS AFFECT ON MAGGOT BEHAVIOR

Evelyn Carreto, Amanda Roe, Ph.D., ecarreto5354@csm.edu
Biology Program, College of Saint Mary, NE

The most common use of forensic entomology in criminal investigations is using maggot development to estimate the post-mortem interval (PMI) or time since death. Previous research has shown that drug exposure can affect maggot development by increasing or decreasing growth rates and physical size, which could potentially affect PMI estimations. However, none of the previous research was interested in maggot behavior changes while exposed to different drugs. Understanding maggot behavior gives insight into how they move in a maggot mass and/or on a carcass, which can also impact development rates. To address this lack of research, we propose to feed maggots different concentrations of three drugs: mephedrone, fluoxetine, and bupropion. For all three drugs, concentrations of 2mg/L, 1mg/L, 0.5mg/L, and 0.25mg/L in distilled water were used. 100 grams of beef liver were soaked for 5 hours in the different concentrations. After soaking, 100 first stage maggots (*Calliphora vicina*) were placed on the liver and allowed to feed through the rest of their life cycle. Maggots and liver were kept at 28 °C. Controls consisted of maggots feeding on non-drugged liver. Maggot behavior was observed for 3 hours daily until the maggots pupated. Changes in behavior between the drugged versus non-drugged maggots were documented through video recording.

DOES KNOCKING OUT THE IMMUNITY REPRESSOR IN A LYSOGENIC BACTERIOPHAGE CAUSE THE PHAGE TO INFECT LYTICLY?

Maddy Sladky, Dr. Erin Doyle, maddy.sladky@doane.edu
Department of Biology, University of Doane, Crete, NE;

With the rise of antibiotic-resistant bacteria, understanding what genes are specific to infecting bacteria can be crucial for the treatment of bacterial infections. Phages can go through two life-cycles: the lytic and lysogenic. Lysogenic phages have not been utilized as much as lytic phages because they have a latent period, which results in their host bacteria being killed at a slower rate. For this research, I have selected a lysogenic bacteriophage, Jabith, and knocked out the immunity repressor using Bacteriophage Recombineering of Electroporated DNA (BRED). The immunity repressor codes for lytic repression, so I predicted that knocking out that suppression, the phage will infect and kill lytically. An oligo was constructed that was used in a transformation that produced plaques. These plaques were screened to detect if homologous recombination was successful in producing mutant phages that did not contain the immunity repressor. Then, the mutant phages were re-plated to test if the mutation would be carried throughout a second generation. I was able to remove the mutation but it has not been successful being carried through a second generation, which may mean that the phage without the immunity repressor is not viable. If a mutant culture does grow, the latent period of the wild-type and mutant will be compared using a growth curve to see if the mutant of the bacteriophage Jabith infects lytically. By finding if the immunity repressor causes a change from lysogenic to lytic behavior, it will help with the understanding and availability of phage therapy treatment.

IMPACT OF LOCAL TEMPERATURE APPLICATION ON SKELETAL MUSCLE MARKERS OF PROTEOLYSIS AND MYOGENESIS

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Many popular temperature-associated post-exercise muscle recovery methods are promoted as beneficial to recovery and performance despite the absence of evidence-based recommendations. However, before investigating the influence of temperature on post-exercise recovery, the exercise stimulus must be removed, and the independent effects of temperature examined. **Purpose:** To determine the impact of local hot and cold thermal wrap application on skeletal muscle markers of breakdown (proteolysis) and growth (myogenesis) at rest. **Methods**: Thermal wraps were applied to the *vastus lateralis* (*VL*) of 24 (19 males, 5 females) healthy subjects (age 26.5±6.5yrs, height 1.77±10.6m, weight 83.2±15.8kg, and BF% 18.7±7.4%) while resting for 4h. One randomized limb received local temperature application of either 40°C (HOT) or 10°C (COLD) via water-filled thermal wraps, with the contralateral limb receiving no treatment (RT, n=24). A one-way ANOVA compared HOT (n=12), RT (n=24), and COLD (n=12) skin temperatures, intramuscular temperatures, blood flow, and gene expression associated with proteolysis and myogenesis via muscle biopsy. **Results:** Skin and intramuscular temperatures were higher in HOT (+2.5°C, $p<0.001$; +0.9°C, $p<0.001$) and lower in COLD than RT (-21.6°C, $p<0.001$; -14.8°C, $p<0.001$; respectively). Blood flow measurements by arterial ultrasound were not different (velocity, $p=0.263$; flow, $p=0.184$; shear, $p=0.450$). Proteolytic gene expression was higher in COLD (*FBXO32*, $p=0.021$ vs. RT; *FOXO3a*, $p<0.001$ vs. RT and vs. HOT; *TRIM63*, $p<0.001$ vs. RT and vs. HOT). Myogenic gene expression was lower in COLD (*MYO-G*, $p<0.001$ vs. RT and vs. HOT*; MYO-D*, $p<0.001$ vs. RT and vs. HOT). Also, the myogenic-related gene, *MYF6* was higher in COLD ($p<0.001$ vs. RT and vs. HOT). Local HOT application did not induce any differences (vs. RT) in gene expression for markers of proteolysis ($p<0.05$) or myogenesis ($p<0.05$). Temperature had no influence over the phosphorylation rate (phosphorylated/total protein) of myogenic proteins (mTOR, p70S6K1, and 4EBP1) compared to RT conditions ($p<0.05$). **Conclusions:** This local cold application intervention enhanced several genes associated with the breakdown (proteolytic) and inhibited several genes associated with the growth (myogenic) of skeletal muscle. These data bring into question *popular* cold-associated post-exercise recovery methods which may limit the transcriptional response associated with muscle development. *Supported by NE-INBRE, NIGMS Funding (P20GM103427).*

A STUDY OF THE RELATIONSHIP BETWEEN OCTAMERIZATION AND ACTIVITY OF 5-AMINOLEVULINIC ACID DEHYDRATASE FROM ESCHERICHIA COLI

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The tetrapyrrole biosynthetic pathway produces important biological products such as hemes, chlorophylls, siroheme, and cobalamin. After the initial production of 5-aminolaevuilinic acid (ALA) in the first step of the pathway, two ALA molecules are combined by 5-aminolaevulinic acid dehydratase (ALAD) to produce porphobilinogen, a structural piece used to create the basic tetrapyrrole structure characteristic of the hemes and chlorophylls. Notably, there are things still not understood about the enzymes that construct this pathway, including ALAD, which is responsible for several life threatening and poorly understood disorders. The purpose of this study was to characterize effect of Mg+2 on the oligomerization and activity of ALAD from E. coli. It has been reported that Mg+2 binding promotes the formation of an octamer and thereby activates the enzyme. Here we report that the presence of a 6X histidine tag on ALAD has the effect of promoting octamerization without activation. We present evidence that in contrast to the untagged ALAD, the tagged version remains octameric even when Mg+2 has been removed via EDTA.

THE EFFECTS OF *HRCC* TYPE III SECRETION PILI ON BACTERIOPHAGE ATTACHMENT

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Bacteriophages are viruses that infect bacteria. Bacteriophages could be a treatment to use against bacterial infections for all organisms instead of using antibiotics. However, more research needs to be put into phage therapy before it can be used for treatments. Different types of bacteriophages are host specific and can only infect a limited range of bacteria. Bacteriophages attach to their host using specific features already on the surface of bacteria such as lipopolysaccharides, teichoic acids, proteins, and flagella.To better understand how bacteriophages attach to bacteria, I will be researching bacteriophage attachment to Pseudomonas syringae pv. tomato DC3000 (Pst DC3000). The main research question that I am trying to answer is if the hrcC type III secretion pili structures on Pst DC3000 bacteria is important for phage attachment. I isolated bacteriophages from soil samples collected from various locations in Nebraska using Pst DC3000 as a host bacteria. I will be infecting Pst DC3000 and a ΔhrcC variant of Pst DC 3000 that lacks the hrcC type III secretion pilus gene. I will be measuring infection rates by quantifying the number of plaques that form on bacterial lawns of each type of bacteria. I hypothesized that there will be less plaques that form on the ΔhrcC than Pst DC 3000. Being able to understand different mechanisms for phage attachment will allow us to understand phage host specificity, and may make it possible to develop phages with a broader host range.

COMPARATIVE ANALYSIS OF THE GUT MICROBIOME OF DOMESTICATED HORSES.

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Studies on the gut microbiome of mammals are part of a rapidly expanding field and have shown important correlations between the microbial composition and the immune system development, animal physiology and overall health. Recent studies on equine gastrointestinal microbiome have indicated that anthropogenic influences during domestication can significantly reshape the horse gut microbiomes. In addition, comparisons between domesticated and wild horses have shown that in genera domesticated horses have lower diversity in their microbiome composition than wild horses. The gut microbiome in mammals typically establishes shortly after birth, where it is most susceptible to environmental and diet factors. In horses, this resident microbiome appears to stabilize about 50 days post-partum, however different plant diets are still expected to have an effect on the mature developed microbiome. In this study we analyzed the microbiome of four domesticated Quarter Horses varying in age from 1 year old to 25 years old. Three of the horses were fed a traditional (12% sweet feed) hay diet, while one of them was on a senior horse feed supplemented with alfalfa pellets. The horse microbiomes were analyzed at two different time points (7 weeks apart). At the time of the second sampling the diet of the senior horse was adapted to include CBD-containing supplements for the treatment of arthritis. Horse gut microbiomes were analyzed by 16SrRNA amplicon sequencing using our in-house Illumina sequencer, and metagenomic data analysis was performed in BaseSpace (Illumina) and MG-RAST. Principle component analysis (PCoA) and detailed comparisons of the metagenomic sequencing showed significant differences that appear to correlate with age and diet. The dominant phyla in the core gut microbiome were Firmicutes, Bacteroidetes, Fibrobacteres, and Verrucomicrobia, with the following genera most represented: *Prevotella* and *Treponema*,. The two older horses had substantially higher levels of *Fibrobacter*. The outcome of this study had potential broader implications for the impact of feeding patterns on the microbiome, and possibly physiology of domesticated horses.

SATB1 HOMODIMERIZATION IS MEDIATED BY THE ULD DOMAIN INDEPENDENTLY OF DNA

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Chromatin reorganization is one of many factors that influence gene regulation, and Satb1 is one of the few proteins that has been implicated in this process. It 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 the protein contains four 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. Furthermore, it is unclear whether Satb1 homodimerization is dependent on DNA. Here we show that a fluorescently-tagged Satb1 is able to drag a nuclear-import deficient mutant of Satb1 into the nucleus, which demonstrates that Satb1 homodimerizes in a DNA-independent manner and that the dimer is stable enough to persist through nuclear import. Further experiments using protein truncations demonstrate that the N-terminal ULD domain of Satb1 is necessary and sufficient for homodimerization.

INVESTIGATION OF BACTERIOPHAGE SUSCEPTIBILITY AND ANTIBIOTIC RESISTANCE IN *STAPHYLOCOCCUS EPIDERMIDIS* ISOLATES FROM HUMAN SKIN

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Antibiotic resistance is becoming an increasingly important issue as more and more bacterial infections are becoming antibiotic resistant. Alternative methods are needed to address this issue and one commonly proposed method is phage therapy. Minimal research has been completed regarding the relationship between phage susceptibility, virulence and antibiotic resistance in skin bacterial isolates. This study will focus on determining if there is a relationship between phage susceptibility and antibiotic resistance in *Staphylococcus epidermidis* skin isolates gathered from Doane University community members. *S. epidermidis* will be used for this research due to its close phylogenetic and functional relationship with *Staphylococcus aureus*, a well characterized nosocomial pathogen, known for aggressive antibiotic resistant infections. To this end, we have set out to isolate and characterize skin swab bacterial samples as well as novel S. epidermidis bacteriophages. This research will be presented in the context of three hypotheses. One hypothesis is that if a bacterial sample is resistant to a greater number of antibiotics, then it will be more susceptible to phages as this has been shown in previous research. An alternative hypothesis is that if a bacterial sample is resistant to a high number of antibiotics, then it will be more resistant to phages because it will more commonly participate in horizontal gene transfer and gain resistant genes. A third hypothesis is that there will be no relationship between antibiotic resistance and phage susceptibility. Future experiments in this project will also investigate the virulence of these isolates both genetically and functionally.

PREVALENCE OF BACTERIAL PATHOGENS IN EASTERN NEBRASKA TICK POPULATIONS

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As cases of Rocky Mountain Spotted fever (*Rickettsia rickettsii*) have increased over the last five years in the state of Nebraska, little is still known about the type of spotted fever group (SFG) *Rickettsia* and their occurrence in the Nebraska tick populations. *Dermacentor variabilis* and *Amblyomma americanum* both found in Nebraska carry a variable number of infectious diseases and different forms of SFG *Rickettsia*. Many SFG *Rickettsia*'s present symptoms like other common diseases making them hard to diagnose. Knowing what diseases are prevalent in the area will be important for easier and more accurate health care diagnosis. Ticks were collected in Eastern Nebraska in different locations along the Platte River and tested for different forms of SFG *Rickettsia* and other known tick transmitted diseases such as *Ehrlichiosis* bacteria and *Francisella tularensis*. This information will help us to identify risk in different areas of Eastern Nebraska.

YELLOW IS FOR BEETLES, BUT BLUE IS FOR BEES: DIFFERENTIAL SAMPLING USING POLLINATOR VANE TRAPS

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The first important step in any biological conservation effort is determining the population status of the species at a site. For pollinating insects, several different techniques have been used. An increasingly popular technique uses commercially-available Blue or Yellow Vane Traps. We set out two pairs of Vane Traps, each with one Blue and one Yellow trap, in patches of flowers known to be highly attractive to pollinators, at Glacier Creek Preserve in Bennington, Nebraska. Six sampling sessions were conducted, approximately every two weeks between July and September 2021, with traps in place for 24 hours each session, from one afternoon to the next. We found that Blue Traps captured significantly more insects overall than did Yellow Traps. Yellow Traps captured significantly more beetles, while Blue Traps captured significantly more bees and butterflies. Our results indicate that use of multiple sampling methods may be necessary to accurately sample pollinator populations at sites of conservation importance.

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 blood host 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 by necrophagous 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.

CHARACTERIZING HIGH PERSISTER PHENOTYPES IN *STAPHYLOCOCCUS EPIDERMIDIS* CLINICAL ISOLATES

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Staphylococcus epidermidis is an opportunistic pathogen that typically resides within our normal skin flora. *S. epidermidis* causes disease in immunocompromised individuals, mediated through indwelling medical devices. Antibiotic treatment of these infections is often unsuccessful, leading to chronic, relapsing infections with poor patient prognosis. A likely explanation for these observations is the presence of persister cells (a subpopulation of dormant cells). High persister isolates have been shown to occur in other microbial pathogens such as *Pseudomonas aeruginosa* and *Candida albicans*. Recent work in the related pathogen, *S. aureus*, demonstrates persister formation is dependent on energy depletion through the tricarboxylic acid (TCA) cycle. Therefore, we hypothesized high persister isolates occur in *S. epidermidis* clinical isolates through an energy-dependent mechanism. To observe the possibility of a correlation between high persister formation and a dysfunctional TCA cycle, extracellular acetate was measured in high and low persister clinical isolates. Acetate concentrations are linked to a functional TCA cycle as disruption or lower activity leads to an accumulation of acetate in the medium. To eliminate variability, multiple samples in triplicates and quadruplets were utilized and grown in fresh Tryptic Soy Broth (TSB). Before running the samples through centrifugation, they were neutralized to obtain a pH within a range of 8.30 and 8.35, as recommended in the assay instructions. Preliminary data collected has demonstrated the seemingly correlational relationship between a dysfunctional TCA cycle and increased persister formation. However, results have demonstrated unaccounted variability through the utilization of a master mix and the microtiter plate. To prevent this variability from recurring, a buffered media, TSB MOPS, was utilized to grow the microorganism. In future experiments, cuvettes will be utilized to help in the detection of the factor leading to variability.

ANTS ALTER EASTERN BLUEBIRD NESTLING CLYCLES: FLEDGING DIFFERENCES BETWEEN TWO POPULATIONS

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Certain factors of the ecosystem affect the fledge rate of bluebird hatchlings. The data that we tested was collected from two different bluebird populations, a golf course and a military base in southern Mississippi. Even though the two sites are about 25 minutes apart, the populations and environment are very different. At the golf course there were only Argentine ants (I*ridomyrmex humilis)* and at the military base there are only Fire ants (*solenopsis sp.)*. We explored if the type of ants affected when nestlings fledge. We ran non-parametric tests and found a correction between the total number of Argentine ants and fledge date at the golf course. We found that the higher the ant density, the longer it took the nestlings to fledge. We hypothesize that the bluebirds are competing with the ants for food and may cause nestlings to fledge later, possibly due to lower growth rates due to reduced food intake as a result of competition.

AGGRESSION AND TESTOSTERONE ARE A PROXY FOR CLUTCH SIZE FOR MALE EASTERN BLUEBIRDS

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It is already established that the male eastern bluebird is more aggressive towards more blue, colorful intrasexual intruders. We investigated if clutch size was a proxy for the levels of aggression and testosterone during nest building. We placed a male bluebird in a small wire cage 0.3m from a focal pair's nest-box during the nest building phase of breeding, and we broadcasted Eastern bluebird song and chatter. For 10 minutes, we recorded the total number of attacks and dives at the intruder, and then we captured the male and took a blood sample. We ran nonparametric tests to see how clutch size was related to male eastern bluebird aggression. We also tested testosterone and corticosterone levels to see if that correlated with clutch size. We found that the more aggressive males had larger clutch sizes. We also found that the males with more testosterone during nest building had greater clutch sizes. During nest building, males expressing more aggression and/or higher testosterone mated with females that went on to lay more eggs. Increased aggression and testosterone during nest building may attract higher quality females for these males. Consistent with the literature there was no relationship between testosterone and aggression.

TRANSCRIPTOMICS ANALYSIS OF CANDIDATE GENES IN *S. VITTATUM* FOR ACCURATE LOCAL TRANSMISSION RATES OF RIVER BLINDNESS

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The parasitic round worm, *Onchocerca volvulus*, causes Onchocerciasis, or river blindness, in humans through the transmission from black flies that take blood meals from humans. More than 95% of individuals who have been infected by river blindness live in Africa and it causes one million Disability Adjusted Life Years (DALYS) *per annum*. The disease causes skin irritations and eye infections which can lead to blindness. Control efforts achieved by ESPEN have been effective by treatment with ivermectin, but COVID-19 has caused the number of people that are treated to decrease significantly. In addition, identification of black flies that carry the parasitic round worm is done through rtPCR by skin snips. Due to river blindness being transmitted through second-cycle black fly females, locating these infected females in an effective manner is a necessity as mapping transmission rates of river blindness has been difficult for many programs. The *Simulium* genus of black flies are responsible for transmitting river blindness to humans. Through transcriptome analysis of the *Simulium vittatum*, the differentiation between first cycle and second cycle black fly females can be achieved by differences in gene expression. The mtDNA of the pre-egg laying and post-egg laying *S. vittatum* females were analyzed with an emphasis on the chromatin modification, histone acetylation and deacetylation, and histone methylation and demethylation. These facets were examined by comparison of their FPKM and effective counts between the pre-egg laying and post-egg laying females to determine which genes are possible markers for identification. Using uniport, the sequences were matched to proteins of different species with that sequence. Proteins that were of interest and had a significant proportional difference in FPKM between pre-egg laying and post-egg laying included: DNA repair protein RAD51 homologs, Transcription-associated protein 1, NAD-dependent histone deacetylases, Histone-lysine N-methyltransferases, and Lysine-specific demethylase lid. These proteins and the genes that make them up are candidate genes for identification between the *S. vittatum* pre-egg laying and post-egg laying females using rtPCR to detect the reproductive stage. This improved model could more accurately calculate local transmission rates as the percentage between parous and nulliparous biting black flies could be found.

SATB1 FORMS HETERODIMERS WITH SATB2 IN A DNA-INDEPENDENT MANNER.

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Chromatin architecture and the proteins that control it play an essential role in gene regulation. DNA is organized on a spectrum from tightly compacted regions called heterochromatin which are primarily composed of silent genes, to loosely arranged structures called euchromatin which mostly contain active genes. Both Satb1 and Satb2 have been implicated in creating and maintaining chromatin architecture. Satb1 is involved in T-cell development and Th1/Th2 differentiation, while Satb2 is critical for RUNX2 expression leading to osteogenesis. Satb1 has been shown to homodimerize in a DNA-independent manner. Given the high degree of homology between Satb1 and Satb2, it has been hypothesized that Satb1 can also heterodimerize with Satb2. Here we show evidence that Satb1/Satb2 heterodimers form in a DNA-independent manner and that the ULD domain of Satb1 is both necessary and sufficient for heterodimer formation.

EFFECT OF ANDROGEN RECEPTOR ON SCENT MARKING BEHAVIOR IN MICE

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Most mammals use olfactory behaviors to either attract or indicate interest in mates. One such behavior is scent marking. Testosterone, an androgen hormone, plays a role in masculinization of the brain by binding to androgen receptors (AR). However, it is unclear whether the presence or absence of AR in male and female rodents affects their olfactory behaviors, including scent marking, towards opposite-sex conspecifics. We hypothesized that the presence or absence of AR in both subject and scent donor mice affect scent marking behaviors in mice. We exposed male and female mice to scent marks of an unknown mouse for 10 minutes, then recorded the number of over-marks made on those scent marks. Our preliminary results showed that wild type (wt) female mice (two copies of a functional AR gene) and tfm male mice (a dysfunctional AR gene) had a higher frequency of over-marking male scent marks. We predicted that the wt males would have a higher frequency of over-marking to female scent marks. Our results suggest that AR plays a role in establishing male-typical patterns of scent marking. This study provides further support of the role of androgens in organizing and activating sex specific behaviors in mammals.

THE INFLUENCE OF TOPICAL MENTHOL GEL ON THERMOREGULATORY AND PERCEPTUAL OUTCOMES DURING EXERCISE WITHIN THE HEAT

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Transient receptor potential melastatin 8 (TRPM8) is responsible for the sensation of cool temperatures. When applied topically, menthol acts upon a cold transduction enzyme to decrease the thermal sensitivity of TRPM8. This allows activation of TRPM8 at warmer temperatures. The "cool" menthol feeling is used widely in everyday commercial products, such as analgesic creams; however, there is a physiological response to the perceived external "cooling." The purpose of this study is to examine the effect of a topically-applied commercial Biofreeze TRPM8-stimulating gel on human thermoregulation during endurance exercise within heated conditions. Participants will be 19-45 years of age, healthy, and active. The first of three visits will involve allergy tests and anthropometric data collection. The subsequent visits will consist of a brisk treadmill walking bout (3.5 mph 5% grade) for 30 min within a heated condition (38°C, 60%RH). Biofreeze menthol gel (EXP) or a non-menthol hypoallergenic gel (CON) will be applied to the arms and legs prior to the exercise bout on randomized visits. Thermoregulatory variables (core body temperature, skin temperature, heart rate, blood flow, and Galvanic skin response) will be collected and recorded continuously throughout the exercise bout via polar monitor, skin surface thermistors, rectal temperature probe, laser Doppler, and GSR device. Thermal sensation will be recorded throughout the study via the ASHRAE thermal sensation scale. In the menthol condition, subjects are expected to perceive cooler temperatures, increase core body temperature to conserve heat, and have decreased skin blood flow to the extremities.

MORE TO LOSE; EASTERN BLUEBIRD FEMALES SHOW DEFENSE THAN MALES AT AN URBAN GOLF COURSE

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Previous research has found that eastern bluebirds (*Sialia sialis)* have repeatable nest defense against house sparrows (*Passer domesticus).* The house sparrow is also a competitor for the eastern bluebird. For our study we used a larger predator, the American Crow. We placed nest boxes at two different locations where the population of bluebirds were going to be surveyed. The two different locations are an urban golf course and rural military base. At the locations we placed a decoy on top of the nest boxes and played nestling distress calls for five minutes. The time of arrival and the number of dives were recorded along with the capture of the birds to collect their blood. We ran nonparametric tests and found that at the golf course the females dive more than the males. At the military base, we found there is correlated nest defense between males and females. The results from the military base are consistent with the literature. At the golf course overall nest defense may be interrupted by increased human traffic. Generally, for females, breeding is a larger investment than it is for males. Therefore, females may invest more in defense because of the more stressful environment as they have more to lose physiologically if they lose a clutch of eggs.

I GOT IT FROM MAMA: EXPLORING THE TRANS-GENERATIONAL EFFECTS LONG-TERM PARASITIC INFECTION HAS ON OFFSPRING

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Investment of energy into reproduction and immunological function is a delicate balance that is essential to an organism obtaining maximum fitness. These systems require a strategic allocation of nutrients, which is easily disrupted upon becoming infected with a pathogen or parasite. While it is well-documented that infection can negatively impact proper investment in reproduction within an individual, we are only just beginning to understand that infection may result in long-term consequences for the fitness of the resulting offspring. Here, we explore the effect a long-lived parasitic infection has on the reproductive fitness of female sand crickets, *Gryllus firmus*, and quantify the trans-generational impacts maternal infection has on their offspring. Specifically, we quantified the following traits for maternal crickets: mating success, number of eggs produced, number of eggs laid, average egg size, hatchling success of laid eggs, total number of offspring hatched, and average hatchling size. For offspring, we investigated how traits indicative of reproduction and immune function were impacted by their mother's health status. Immune function was measured using host-resistance assays to an LD_{50} dose of the common bacterial pathogen *Serratia marcescens* and by quantifying the degree of melanization of a monofilament inserted into the abdominal cavity of the offspring. Offspring reproductive investment was analyzed by conducting sperm viability assays and quantifying testes mass for males and quantifying ovarian mass for females. Preliminary results from these measurements suggest that ovarian mass is significantly decreased during the infection period in parasitized maternal crickets, thereby drastically limiting offspring production. In addition, there has been no significant association between infection rate and mating success in female crickets observed. The reproductive capacity of maternal crickets, and the trans-generational effects seen in their offspring are currently being investigated.

EFFECT OF AGE AND FOOD DEPRIVATION ON ANXIETY-LIKE BEHAVIOR IN MICE

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Stress and anxiety motivate and influence behavior, but the mechanisms by which they do so are not fully understood. Hormones are a key biological factor that mediate behavior. Androgens, such as testosterone, act through the androgen receptor (AR) to ameliorate anxiety-like behaviors in rodents, as wild-type (wt) males exhibit lower anxiety-like behavior relative to wt female mice and male mice with dysfunctional ARs (testicular feminization mutant (tfm) male mice). Gonadal hormone levels are affected by both an animal's age and nutritional state. An animal's nutritional state is determined by the amount and quality of food consumed. Therefore, the objective of this study was to determine whether food deprivation induces anxiety-like behavior in juvenile and adult wt male, wt female, and tfm male mice and whether such behavior is associated with changes in gonadal steroid hormone levels. Mice were isolated one week before anxiety testing to prevent influence of social interaction. Adult (approximately 11-13 weeks old) and juvenile (approximately 5-6 weeks old) mice were assigned to one of three treatments: 6 hr food deprivation, 24 hr food deprivation, or continuous access to food. Anxiety-like behavior was measured using an elevated plus maze (EPM). Adult male wt mice that were food-deprived for 24 hrs tended to spend more time in the open arm of the EPM relative to adult female wt mice that were also food-deprived for 24 hrs. These results suggest testosterone plays a role in modulating anxiety related behavior. Further analysis of behavior, brain tissue, and blood hormone levels will allow for clarification of the specific mechanism through which behavior is modulated.

TEMPORAL GENE EXPRESSION ANALYSIS OF UNO-SLW2 INFECTION OF *PSEUDOMONAS FLUORESCENS* USING BIOINFORMATICS METHODOLOGIES

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Despite their widespread nature, *Pseudomonas* bacteriophages are poorly understood. Accordingly, using novel Podoviruses (UNO-SLW1-4) that have been isolated in our laboratory and the *Pseudomonas fluorescens* host, we seek to clarify the mechanisms and functions of their "hypothetical" genes and gene products. RNA sequencing will especially shed light on gene expression changes during viral infection, illuminating the phage genes previously unrecognized during infection of *P. fluorescens* over time and as they induce an oxidative stress response. These genes are initially found using high throughput sequencing methods and functionally annotated for characterization of phylogenetic homology using whole-genome sequences. Genetic similarities between common hypothetical gene regions identify potential sources or causes of differential pathogenicity between various *Pseudomonas* bacteriophage strains. Algorithmic analysis and taxonomic classification of these genes will identify which category of genes are most commonly expressed, given that previous results have shown a strong incidence of unknown structural components. Moreover, by mapping the course of gene expression in conjunction with the infection progress of *P. fluorescens* and its bacteriophage, we learn more about the genes and gene products expressed at specific stages of growth, for both the host and virus. Initial analyses have already identified proteins involved in this infection mechanism. Overall, using such bioinformatics temporal gene expression analyses, we validate a genetic surveillance workflow. This methodology elucidates virulence factors of common nosocomial *Pseudomonas* bacteriophages, and how they dysregulate the growth of *Pseudomonas* bacteria. This will provide greater insight into bacteria in the *Pseudomonas* genus, including those that cause human disease.

REMOTE DETECTION OF *MACRHYBOPSIS STORERIANA* USING EDNA MARKERS

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The Silver Chub (*Macrhybopsis storeriana)* is a species of freshwater fish that serves as a forage species for bass and may help prevent the spread of the invasive Zebra Mussel. The Silver Chub is experiencing dramatic population declines because of anthropogenic alterations including water quality deterioration, a decrease in food, and habitat modification. The Silver Chub is the only *Macrhybopsis* chub to be found in a lake environment, and therefore may represent a unique lineage for this genus. Monitoring population status for this species, particularly for this unique lineage in vital, however, many monitoring efforts result in damaging individuals. In this study we aim develop an eDNA marker based on the 12S gene to provide a non-invasive method to detect Silver Chub.

IMPORTANCE OF ANTHOCYANIN EXPRESSION IN THE COLORLESS LIATRIS PUNCTATA WITHIN THE PRIMER/ENZYME PATHWAYS

Megan McGuire, memcguire@my365.bellevue.edu
Department of Biology, Bellevue University, Bellevue, NE

Anthocyanin is a compound with colors varying from orange, red, and purple to blue in flowers, seeds, fruits, and vegetative tissues (Tanaka and Ohmiya, 2008). As anthocyanins are water-soluble pigments primarily located in cell vacuoles, their hue, a color property, is influenced by the intravacuolar environment. They also play a vital role in reproduction, attracting pollinators, and seed dispersion within various plant species (Liu et al., 2018). There is now evidence of anthocyanins having health-promoting properties, making it an exciting study target. Activation of the anthocyanin pathway during petal development requires a complex interaction between environmental and developmental signals (Weiss, 2001). We will be taking a closer look into these pathways. How anthocyanins are expressed in individual plants is based on the flavonoid pathway in the cytoplasm of the colored plant cell (Harvard, 2013). We will be looking at the anthocyanin protein/enzyme pathways in *Liatris punctata.* To look at the anthocyanin pathways in *Liatris*, we will be sequencing the genome by using *Echinacea* as the starter. We will PCR the two samples and send them off for sequencing. Once they return, we will take the sample and genome walk until we create a partial genome for the *Liatris* sample. The goal will be to isolate the protein of the anthocyanin that is deleted. If no mutation is found, we will dig deeper into a possible mutation in the plant itself. This project is still ongoing at Bellevue University with Dr. Scott Pinkerton.

BIOMEDICAL SCIENCES SECTION Chairperson: **Annemarie Shibata**

FRIDAY, APRIL 22 **Location: Olin Hall**
Session A Olin LH-A
Session B Olin LH-B
Session C Olin Planetarium

MORNING SESSION - A1 **Location: Olin Lecture Hall Room Olin LH-A**

Chairperson(s): Joseph Dolence, University of Nebraska-Kearney

7:30 Presenters upload talks from USB drives onto the room computer desktop.

7:45 ZOOM Session opens for participants to join https://unk.zoom.us/j/96490656752

If you need assistance connecting via Zoom, or finding the right session, please contact UNL's CSMCE Home Room Support team

8:00 ANALYSIS OF THE VAGINAL MICROBIOME IN RELATION TO INFLAMMATORY SIGNALS. Phoebe Peña, Sophia Sanchez, Peter Angeletti, and Tierney Lorenz (abstract)

8:15 FADD32 INHIBITION STUDIES USING NOVEL COUMARIN-BASED COMPOUNDS. Erin Hebert, Jackson Fox, Jeffrey North, and Lynne Dieckman (abstract)

8:30 BACTERIAL DISEASE PRESENCE IN HALL COUNTY, NEBRASKA TICK POPULATIONS. Sarah Chandler, Sam Mercer, and Julie Shaffer (abstract)

8:45 DISCOVERING A NOVEL PROTEIN-PROTEIN BINDING MECHANISM: THE PCNA AND CAF-1 INTERACTION. Keely Orndorff and Lynne Dieckman (abstract)

9:00 JUMPING SPECIES: SPILLING THE BEANS ON THE NEXT EPIDEMIC. Samantha Mercer, Darby Carlson, and Julie Shaffer (abstract)

9:15 PSYCHOPHARMACEUTICAL IMPACT ON STEROL SYNTHESIS IN DEVELOPMENT. Nathan Zimmerman, Aaron Marta, Carly Baker, Thiago Genaro-Mattos, Zelijka Korade, and Annemarie Shibata (abstract)

MORNING SESSION - B1 **Location: Olin Hall, Room Olin LH-B**

Chairperson(s): Kimberly A. Carlson, University of Nebraska-Kearney

7:30 Presenters upload talks from USB drives onto the room computer desktop.

7:45 ZOOM Session opens for participants to join https://unk.zoom.us/j/94556070264
Meeting ID: 945 5607 0264

If you need assistance connecting via Zoom, or finding the right session, please contact UNL's CSMCE Home Room Support team

8:00 COMPARATIVE ANALYSIS OF THE STRUCTURAL DYNAMICS OF THE DOPPEL PROTEIN AND THE C-TERMINUS OF THE CELLULAR PRION PROTEIN. James Janos, Linh Bui, Kaitlin Tsuchida, and Patricia Soto (remote) (abstract)

8:15 CHARACTERIZING *BORRELIA BURGDORFERI'S* RESPONSES TO PH CHANGES. Meera Cao, Amanda Zalud, and Travis Bourret (remote) (abstract)

8:30 COMPUTER SIMULATION OF COST AND BENEFITS OF ROBOTIC VS TRADITIONAL SURGERIES Peter Sondag (remote) (abstract)

8:45 IMPLEMENTATION OF 3D DORSAL ROOT GANGLION EXPLANT CULTURE PLATFORM FOR SCREENING CHONDROITIN SULFATE NEURO-INHIBITORY MICROPARTICLES. Alvaro Moreno Lozano, Fei San Lee, and Rebecca A. Wachs (abstract)

9:00 ANALYSIS OF BACTERIAL GROWTH IN THE PRESENCE OF glmS RIBOSWITCH LIGAND ANALOGS. Alexandra Van Cleave and Juliane Soukup (abstract)

9:15 NOVEL HUMAN LONG NON-CODING RNAS MODULATE IONIZING RADIATION-INDUCED NEUROINFLAMMATION. Nicholas W. Mathy and Annemarie Shibata (abstract)

MORNING SESSION - C1 **Location: Olin Hall Lower level, Planetarium**

Chairperson(s): Annemarie Shibata, Creighton University

7:30 Presenters upload talks from USB drives onto the room computer desktop.

7:45 ZOOM Session opens for participants to join https://creighton.zoom.us/j/98631888203 Meeting ID: 986 3188 8203

If you need assistance connecting via Zoom, or finding the right session, please contact UNL's CSMCE Home Room Support team

8:00 LAUGHTER: THE BEST MEDICINE. Jaelynn Williams (remote) (abstract)

8:15 A COMPUTER MODEL OF PHYSICIAN SHORTAGE IN THE UNITED STATES. Kia Liermann (remote) (abstract)

8:30 POLYAMINE-INDUCED CONFORMATIONAL CHANGES IN THE HUMAN OAZ-PK RNA. Jessica Lemke, Diego Gomez, Rhiannon McCraken, Spencer Thompson, Siddharth Venkatraman, and Juliane Soukup (abstract)

8:45 INCREASED PERSISTER FORMATION IN *STAPHYLOCOCCUS AUREUS* LEADS TO INCREASED SURVIVAL WITHIN A HOST. Trenten Theis, Trevor Daubert, Kenan Brodd, Kennedy Kluthe, and Austin Nuxoll (abstract)

9:00 ANDROGENS NEGATIVELY REGULATE THE ALLERGIC IMMUNE RESPONSE TO PEANUT. McKenna S. Vininski, Sunanda Rajput, Nicholas J. Hobbs, and Joseph J. Dolence (abstract)

9:15 IMPACT OF HELPER ILCS AND ANTI-PD1 SUPPLEMENTATION IN NK-CELL MEDIATED CANCER CELL KILLING. Maia M.C. Bennett, Anna R. Mahr, Alexander K. Regan, Arriana Blackmon, and Paul W. Denton (abstract)

9:30 **BREAK**
Presenters upload talks from USB drives onto the room computer desktop.

MORNING SESSION - A2 **Location: Olin Lecture Hall Room Olin LH-A**

Chairperson(s): Joseph Dolence, University of Nebraska-Kearney

9:40 ZOOM Session opens for participants to join https://unk.zoom.us/j/96490656752

If you need assistance connecting via Zoom, or finding the right session, please contact UNL's CSMCE Home Room Support team

9:45 IMPACT OF HER2 EXPRESSION AND HYPOXIC CULTURE CONDITIONS ON MITOCHONDRIAL ENERGETICS *IN VITRO*. George Varghese, Tahmina A. Gafurova, Hayden M. Hubbs, Cecilia Myers, Alicia C. Nguyen, Greer L. Porter, Samuel J. Rogers, Daniel R. Snyder, Fiona M. Sun, Thien Q. Tran, Jake S. Wakahiro, Daniel H. Wood, and Michael G. Nichols (abstract)

10:00 METABOLIC IMAGING BY NAD(P)H PHASOR-FLIM AND SHG AS A NON-INVASIVE DIAGNOSTIC TECHNIQUE FOR SKIN CANCER. Samuel J. Rogers, Tyler B. Farr, Tahmina A. Gafurova, Hayden M. Hubbs, Connor J. Kalhorn, Cecilia Myers, Alicia C. Nguyen, Greer L. Porter, Megan K. Schultz, Daniel R. Snyder, Fiona M. Sun, Thien Q. Tran, George Varghese, Jake S. Wakahiro, Daniel H. Wood, Laura A. Hansen, Michael G. Nichols (abstract)

10:15 DETECTION OF NOVEL REPEAT REGIONS WITHIN THE *TOXOPLASMA GONDII* GENOME FOR CLINICAL DIAGNOSIS. Braydon Dreher, Ryan Chapman, and Paul H. Davis (abstract)

10:30 *STAPHYLOCOCCUS AUREUS* PERSISTERS EXHIBIT INCREASED SURVIVAL TO COMPONENTS OF THE INNATE IMMUNE SYSTEM. Emma Weis, Trenten Theis, Alexis Hobbs, Kennedy Kluthe, and Austin Nuxoll (abstract)

10:45 ADVANCING RADIOIMMUNOTHERAPY FOR BRAIN TUMORS USING *IN VITRO* ASSAYS. Yohan Walter, Olivia Salas, Allison Benoit, Destiny Jordan, Erika Jank, Anne Hubbard, and Andrew Ekpenyong (abstract)

MORNING SESSION – B2 **Location: Olin Hall, Room Olin LH-B**

Chairperson(s): Kimberly A. Carlson, University of Nebraska-Kearney

9:40 ZOOM Session opens for participants to join
https://unk.zoom.us/j/94556070264 Meeting ID: 945 5607 0264

If you need assistance connecting via Zoom, or finding the right session, please contact UNL's CSMCE Home Room Support team

9:45 THE ROLE OF MOMP AS A TARGET FOR AN mRNA *CHLAMYDIA* VACCINE. Jasmine Sparrock and Douglas Christensen (abstract)

10:00 VIRTUAL SCREENING OF NATURAL PRODUCT PYRUVATE DEHYDROGENASE KINASE INHIBITORS. Nathan Fancher and Michael Moxley (abstract)

10:15 MEASURING RESPONSE TO AG825 TREATMENT AND CULTURE CONDITIONS ACROSS MULTIPLE CANCER CELL LINES VIA NAD(P)H PHASOR-FLIM. Thien Q. Tran, Tahmina A. Gafurova, Hayden M. Hubbs, Alicia C. Nguyen, Greer L. Porter, Samuel J. Rogers, Megan K. Schultz, Daniel R. Snyder, Fiona M. Sun, George Varghese, Jake S. Wakahiro, Daniel H. Wood, and Michael G. Nichols (abstract)

10:30 NF-kB SIGNALING IN TRIPLE NEGATIVE BREAST CANCER. Joshua Kruse, Isioma Akwanamnye, Lelisse Umeta, Feven Hailemariam, and Ann Buchmann (abstract)

10:45 STRUCTURAL AND FUNCTIONAL ANALYSIS OF *CRASSOSTREA GIGAS* OAZ-PK RNA Rhiannon McCracken, Spencer Thompson, Siddharth Venkatraman, and Juliane Strauss-Soukup (abstract)

MORNING SESSION – C2 **Location: Olin Hall Lower level, Planetarium**

Chairperson(s): Annemarie Shibata, Creighton University

9:40 ZOOM Session opens for participants to join
https://creighton.zoom.us/j/98631888203 Meeting ID: 986 3188 8203

If you need assistance connecting via Zoom, or finding the right session, please contact UNL's CSMCE Home Room Support team

9:45 POTENTIAL FOR VIRAL REPLICATION WITHIN THE BRAIN OF NORA VIRUS-INFECTED *DROSOPHILA MELANOGASTER*. Blase Rokusek, Britney de Leon, Sunanda Rajput, Nicholas Hobbs, and Kimberly A. Carlson (abstract)

10:00 MODULATION OF INTERFERON REGULATORY FACTOR 7 PRODUCTION AND ANTIVIRAL RESPONSE THROUGH LINCRNA-NOSTRILL IN MICROGLIA. Olivia Burleigh, Nicholas Mathy, Annemarie Shibata and Kristen Drescher (abstract)

10:15 PRIMATE-SPECIFIC INTERFERON REGULATORY FACTOR 9 (PS-IRF9) AND ITS ROLE IN INTERFERON SIGNALING PATHWAYS. Jordan Rasmussen and Luwen Zhang (abstract)

10:30 ANALYSIS OF IMMUNE REGULATED GENE IN A DROSOPHILA MELANOGASTER MODEL OF PEANUT ALLERGY. Emma Collins, Bethany Burklund, Blase Rokusek, Alexis Hobbs, Joseph J. Dolence, and Kimberly A. Carlson (abstract)

10:45 CPT2 DEFICIENCY AND THE EFFECTS ON BODY AND BRAIN DEVELOPMENT. Carly Baker, Aaron Marta, Nathan Zimmerman, Ken Kramer, Holly Stessman, and Annemarie Shibata (abstract)

11:00-12:00 **MAIBEN LECTURE** **Olin Hall Lecture Hall 'B'**
https://unl.zoom.us/j/9289316099

Dan Sitzman, Lecture Title: *History of the Nebraska Academy of Sciences*

12:00-12:30 **BUSINESS MEETING** **Olin Hall Lecture Hall 'B'**
https://unl.zoom.us/j/9289316099
Nebraska Academy of Sciences (all members)
State of the Academy
Awards Ceremony
Comments from Members-at-Large

12:30 – 1:30 **LUNCH** Student Center Cafeteria (pre-purchase ticket or pay-at-door)

1:00 – 1:20 ***NAS Future Leaders Panel*** in the **Sunflower Room** (Student Center by the Cafeteria) join the informal discussion to learn how you can help lead NAS into the future

AFTERNOON SESSION - A3

Chairperson(s): Benjamin Brandsen PhD, Creighton University

1:15 Presenters upload talks from USB drives onto the room computer desktop

1:25 p.m. ZOOM Session is open for participants to join https://creighton.zoom.us/j/96903381497

If you need assistance connecting via Zoom, or finding the right session, please contact UNL's CSMCE Home Room Support team

1:30 DETERMINING THE INFLAMMATORY IMPACT OF LONG NON-CODING RNA EXPRESSION IN OTOTOXICITY USING AN AUDITORY CELL LINE. Collin Jackson, Nick Mathy, Olivia Burleigh, Peter Steyger, and Annemarie Shibata (abstract)

1:45 DEVELOPING 3D HYDROGEL SCAFFOLD AND SCAFFOLD LESS SYSTEMS THAT ENABLE HUMAN MESECENHYMAL STEM CELL GROWTH AND TRANSFECTION. Marusha Ather, Sophie Walsh, Luke Samuelson, Angela Pannier (abstract)

2:00 DENDRITIC CELLS DISPLAY SEX-SPECIFIC DIFFERENCES IN ABILITY TO MOUNT IMMUNE RESPONSE TO PEANUT. Tyler Shaner, McKenna S. Vininski, Sunanda Rajput, and Joseph J. Dolence (abstract)

2:15 THE MOLECULAR MECHANISM OF EARLY SYNAPTIC LOSS IN ALZHEIMER'S DISEASE. Han Le, Sivaprathan Nagappan Chettiar, and Hisahi Umemori (abstract)

2:30 TARGETING CANCER STEM CELLS USING RK-33: A NOVEL THERAPEUTIC STRATEGY IN PANCREATIC CANCER. Katherine Timboe, Rama Nimmakayala, Sanchita Rauth, Surinder K. Batra, and Moorthy Ponnusamy (abstract)

2:45 DIABETIC TRIPLE NEGATIVE BREAST CANCER: POLYAMINE ENZYMES, ORNITHINE DECARBOXYLASE AND SPERMINE OXIDASE AS POTENTIAL TARGETS. Hadassha Tofilau, Robert Casero, Jr., and Surabhi Chandra (abstract)

3:00 DETERMINING THE MECHANISM OF ACTION OF AN IMMUNOMODULATING, ANTI-SCHISTOSOMAL COMPOUND SA01. Sarah Alsuleiman, Caleb Sandall, Thomas Schultz, Andrew Neville, and Paul Davis (abstract)

3:15 BLOCKING ERK MODULATES INTERFERON PRODUCTION IN RAW 264.7 MACROPHAGES. Danielle Baldi and Tyler Moore (abstract)

3:30 **BREAK**

3:30-5:00 **POSTER SESSION**

5:00 – 7:00 **SOCIAL EVENT** at **LUX Center for the Arts**
Meet with colleagues, make connections, socialize; snacks and soft-drinks, and a cash-donation bar 2601 N. 48th Street, two blocks away https://www.luxcenter.org/

AFTERNOON SESSION – B3

Chairperson(s): Surabhi Chandra PhD, University of Nebraska-Kearney

1:15 Presenters upload talks from USB drives onto the room computer desktop

1:25 p.m. ZOOM Session is open for participants to join https://unk.zoom.us/j/98939437944

If you need assistance connecting via Zoom, or finding the right session, please contact UNL's CSMCE Home Room Support team

1:30 REARRANGEMENT REACTIONS OF ETHER-CONTAINING 1,3,4-TRISUBSTITUTED-1,2,3-TRIAZOLIUM SALTS. Demi R. Brown and James T. Fletcher (abstract)

1:45 EXAMINATION OF SEX-SPECIFIC DIFFERENCES IN TYPE 2 INNATE LYMPHOID CELLS AND ADAPTIVE IMMUNE RESPONSES FOLLOWING PEANUT EXPOSURE.

Leigh-Anne Lehmann, McKenna S. Vininski, Sunanda Rajput, and Joseph J. Dolence (abstract)

2:00 SYNTHESIS, UV-VIS PROPERTIES AND ANTIMICROBRIAL EVALUATION OF MULTIVALENT 1,2,3-TRIAZOLIUM SALTS. Laura Cogua and James Fletcher (abstract)

2:15 SCREENING OF NON-PURINE LIGANDS BINDING TO ADENOSINE RECEPTORS A1, A2A, A2B, AND A3. Mary Fiala, Luke Hamilton, Mahesh Pattabiraman, and Surabhi Chandra (abstract)

2:30 THE USE OF CANTHARIDIN IN COMBINATION WITH MELPHALAN TO INDUCE APOPTOSIS AND INHIBIT CELLULAR PROLIFERATION OF MULTIPLE MYELOMA CELLS. Daniel Schwenneker and Dannielle Peekenschneider (abstract)

2:45 EXAMINING THE ROLE OF *CHLAMYDIA TRACHOMATIS* IN ALTERING INTRA-GOLGI TRAFFICKING KINETICS. Isioma Akwanamnye and Elizabeth Rucks (abstract)

3:00 CELL-FREE BIOSYNTHESIS OF THE LASSO PEPTIDE KLEBSIDIN. Tyler Woodward and Benjamin Brandsen (abstract)

3:15 CHARACTERIZING THE IMMUNE RESPONSE OF CELLS TREATED WITH NOVEL ANTI-SCHISTOSOMAL COMPOUND. Caleb Sandall and Paul H. Davis (abstract)

3:30 SATB1 FORMS HETERODIMERS WITH SATB2 IN A DNA-INDEPENDENT MANNER. Reagan Petersen and Brett Schofield (abstract)

3:45 **BREAK**

3:30-5:00 **POSTER SESSION**

5:00 – 7:00 **SOCIAL EVENT** at **LUX Center for the Arts**
Meet with colleagues, make connections, socialize; snacks and soft-drinks, and a cash-donation bar 2601 N. 48th Street, two blocks away https://www.luxcenter.org/

AFTERNOON SESSION – C3

Chairperson(s): Andrew Ekpenyong, Ph.D. Creighton University

1:15 Presenters upload talks from USB drives onto the room computer desktop

1:25 ZOOM Session is open for participants to join https://creighton.zoom.us/j/6913915839

If you need assistance connecting via Zoom, or finding the right session, please contact UNL's CSMCE Home Room Support team

1:30 STRUCTURAL STUDIES OF THE INTERACTION BETWEEN PROTEINS INVOLVED IN GENE SILENCING. Molly Dolan and Lynne Dieckman (abstract).

1:45 DEVELOPING A NEW METHOD TO MAKE AN INSERT TO PROTECT DNA Charlie Polen and Kristy Kounovsky-Shafer (abstract)

2:00 THE ROLE OF INLB AS A TARGET FOR mRNA LISTERIA VACCINE. Hanna Gebremeskel and Douglas Christensen (abstract)

2:15 HIGHLY DIVERSE LASSO PEPTIDES FROM A SINGLE BIOSYNTHETIC PATHWAY. Kelly Johnson and Benjamin Brandsen (abstract)

2:30 MEASURING MITOCHONDRIAL ENERGETICS BY NAD(P)H PHASOR FLIM AND SHG IMAGING TO COMPARE HEALTHY AND CANCEROUS CELLS. Daniel H. Wood, Tahmina A. Gafurova, Hayden M. Hubbs, Connor J. Kalhorn, Cecilia Myers, Alicia C. Nguyen, Greer L. Porter, Samuel J. Rogers, Megan K. Schultz, Daniel R. Snyder, Fiona M. Sun, Thien Q. Tran, George Varghese, Jake S. Wakahiro, Laura A. Hansen, Michael G. Nichols (abstract)

2:45 SUPRAMOLECULAR PHOTOCYCLOADDITION CHEMISTRY: STEREO- AND REGIOSELECTIVE SYNTHESIS CINNAMIC ACID DIMERS AND THEIR BIOLOGICAL STUDY. Marissa Hoover, Rahn Johnson, Poonam Puntambekar, and Mahesh Pattabiraman (abstract)

3:00 INVESTIGATING ENZYMATIC RESISTANCE TO FOSFOMYCIN BY FOSB IN GRAM-POSITIVE BACTERIA. Alisha Huynh, Joseph Keating, and Mary E. Keithly (abstract)

3:15 IMPACT OF LOCAL TEMPERATURE APPLICATION ON SKELETAL MUSCLE MARKERS OF PROTEOLYSIS AND MYOGENESIS. Mark McGlynn, Monica Kwon, Larry Robins, Liz Pekas, Christopher Collins, and Dustin Slivka (abstract)

3:30 **BREAK**

3:30-5:00 **POSTER SESSION** (see list of posters below)

5:00 – 7:00 **SOCIAL EVENT** at **LUX Center for the Arts**
Meet with colleagues, make connections, socialize; snacks and soft-drinks, and a cash-donation bar 2601 N. 48th Street, two blocks away https://www.luxcenter.org/

POSTER SESSION

Smith Curtis Hall - Main Level

BMS -1 PHYSIOLOGICAL SIGNIFICANCE OF SUPEROXIDE DISMUTASE IN *S. AUREUS*. Faith Kozisek, Sasmita Panda, Vinai C Thomas, and Sujata S Chaudhari, (abstract)

BMS-2 FLUORESCENCE GUIDED MORPHOMETRY IN CHEMO-RADIOTHERAPY AGAINST BRAIN CANCERS. Allison Benoit, Erika Jank, Olivia Salas, Anne Hubbard, Yohan Walter, and Dr. Andrew Ekpenyong (abstract)

BMS-3 SECONDARY AND TERTIARY STRUCTURE OF GENOMIC RNA FROM NEURTROPIC ENTEROVIRUSES. Connor Eastman, and William Tapprich (abstract)

BMS-4 THERMOREGULATION WITH CHEMICAL ACTIVATION OF TRPV1 RECEPTORS. Marie Powers and Dustin Slivka (abstract)

BMS-5 CELL MORPHOMETRY FOR ADVANCING NANOPARTICLE-MEDIATED RADIOTHERAPY AGAINST GLIOBLASTOMA. Erika Jank, Olivia Salas, Allie Benoit, Yohan Walter, Anne Hubbard, and Dr. Andrew Ekpenyong (abstract)

BMS-6 IMMUNE CELL METABOLISM MODELING. Ronit Gandhi and Dr. Tomas Helikar (abstract)

BMS-7 VALIDATION OF SMALL-MOLECULE, NON-NUCLEOSIDE INHIBITORS TARGETING VIRAL RNA-DEPENDENT RNA POLYMERASE IN *FLAVIVIRIDAE*. Sarah Altman (abstract)

BMS-8 MATCHA & MELPHALAN FOR MULTIPLE MYELOMA: THE EFFECTS OF COMBINING GREEN TEA-DERIVED EGCG WITH MELPHALAN ON HUMAN MULTIPLE MYELOMA CELLS Ashleigh Avecilla and Danielle Peekenschneider (abstract)

BMS-9 ANALYSIS OF THE EFFECTS OF MELPHALAN IN COMBINATION WITH PUNICALAGIN ON RPMI 8226 MULTIPLE MYELOMA CELLS. Grace Spieker and Danielle Peekenschneider (abstract)

BMS-10 CAVITAND-MEDIATED CROSS-PHOTOCYCLOADDITION OF ARYLALKENES Hilary Vaughn, Mahesh Pattabiraman, and Surabhi Chandra (abstract)

BMS-11 FATE MAPPING REVEAL HETEROGENEITY IN COCHLEAR MACROPHAGES IN STEADY STATE AND AFTER ACOUSTIC TRAUMA Elyssa Pereyra, Andrew Stothert, Lyudmila Batalkina, Vijayprakash Manickam, Kaira Church, and Tejbeer Kaur (abstract)

BMS-12 NEURONAL AND BEHAVIORAL EFFECTS OF CPTII DEFICIENCY MODELED IN ZEBRAFISH Aaron Marta, Carly Baker, Nathan Zimmerman, Ken Kramer, Holly Stessman, and Annemarie Shibata (abstract)

BMS-13 MACHINE LEARNING APPROACH FOR PREDICTING FLOWERING DAYS IN SORGHUM Aime Nishimwe, Ravi Mural, Mackenzie Zwiener, Marcin Grzybowski, Yufeng Ge, and James Schnable (abstract)

BMS-14 IMPACT OF RADIOTHERAPY AND CHEMOTHERAPY ON NEURONAL CELLS. Destiny Jordan, Yohan Walters, Anne Hubbard, and Dr. Andrew Ekpenyong (abstract)

BMS-15 CHARACTERIZATION OF THE K. LACTIS SPINDLE POLE BODY Zachary Rinke and Ann Cavanaugh (abstract)

5:00 – 7:00 **SOCIAL EVENT** at **LUX Center for the Arts**
Meet with colleagues, make connections, socialize; snacks and soft-drinks, and a cash-donation bar 2601 N. 48th Street, two blocks away https://www.luxcenter.org/

ANALYSIS OF THE VAGINAL MICROBIOME IN RELATION TO INFLAMMATORY SIGNALS

Phoebe Peña[1], Sophia Sanchez[2], Peter Angeletti[1], and Tierney Lorenz[2], ppena@huskers.unl.edu

1 - Nebraska Center for Virology, School of Biological Sciences, University of Nebraska-Lincoln, NE

2 - Center for Brain, Behavior, and Biology, Department of Psychology, University of Nebraska-Lincoln, Lincoln, NE

The Angeletti Lab, in the Nebraska Center for Virology (NCV), is collaborating with the Lorenz Lab, in the Center for Brain, Behavior, and Biology (CB3), on a project to analyze the vaginal microbiome with relation to immune markers. The presence of epitheliotropic bacteria, such as bacterial vaginosis associated bacterium (BVAB1, BVAB2), *Gardnerella vaginalis* and *Atopobium vaginae* can disrupt the equilibrium of the vaginal microbiome. Dysregulation of the microbiome can also lead to reduction in populations of protective flora such as the *Lactobacillus* species *gasseri, iners, helveticus and casei*. High levels of pathogenic microbes attacking the epithelial lining can trigger inflammation. Thus, further elucidation of the relationship between the vaginal microbiome composition and inflammation is important. We hypothesize that inflammatory signals such as interleukin 1 and 6 (IL-1, IL-6) will be associated with the presence of the more pathogenic bacteria. We genotyped 34 vaginal samples for the presence of any of the protective and/or pathogenic bacterial species aforementioned. This analysis was achieved by the use of species-specific multiplex polymerase chain reaction (mPCR). After mPCR, the bacterial species were identified by running a polyacrylamide gel to visualize the molecular weights of each amplicon, which are unique to each species. The bacteria represented on each gel were recorded for further analysis. The proportion of each bacterial species was compared between samples with low and high levels of inflammatory markers such as IL-1 and IL-6. Our results indicate differences in the vaginal microbiome as a function of the inflammatory status.

FADD32 INHIBITION STUDIES USING NOVEL COUMARIN-BASED COMPOUNDS

Erin Hebert[1], Jackson Fox[1], Jeffrey North[2], Lynne Dieckman[1]
1 - Creighton University Department of Chemistry and Biochemistry
2 - Creighton University Department of Pharmacy Sciences

The disease tuberculosis is caused by the slow-growing bacteria *Mycobacterium tuberculosis* (*M. tb*). *M. tb* has displayed an increasing rate of multi-drug resistance over the last 20 years, necessitating the development of novel anti-TB compounds. A promising target of these compounds is the pathway that synthesizes mycolic acids, a fatty acid component of the cell wall that is unique to mycobacterium and essential to the cell wall integrity, permeability, and virulence of *M. tb*. Fatty acid degradation protein 32 (FadD32) is a fatty acyl-AMP ligase required for the synthesis of mycolic acids in the cell wall of *M. tb* and is therefore a potential therapeutic target of anti-TB drugs. Previous studies have identified coumarin-based compounds as effective inhibitors of FadD32; however, they have displayed incredibly short half-lives and are thus not ideal for therapeutics. We have synthesized novel coumarin-based compounds with increased stability by making substitutions to previously identified inhibitors in areas of high metabolic activity. Preliminary enzymatic inhibition studies show that some of these novel compounds retain their inhibition of FadD32 activity. Current studies are being carried out to measure the IC_{50} values of the compounds and determine their potency. These results suggest new therapeutic treatments of tuberculosis may be possible through inhibition of mycolic acid synthesis.

BACTERIAL DISEASE PRESENCE IN HALL COUNTY, NEBRASKA TICK POPULATIONS

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The *Amblyomma americanum* and *Dermacentor variabilis* tick species are established along the Platte River in Nebraska. Of concern are the pathogens they vector. *A. americanum*, the Lone Star tick, can host such bacteria as *Ehrlichia chaffeensis*, *Francisella tularensis*, *Anaplasma phagocytophilum*, *Rickettsia amblyommatis,* and the yet unknown causative agent of Southern Tick Associated Rash Illness. *D. variabilis*, the American Dog tick, typically hosts *Rickettsia rickettsii* and *Francisella tularensis*, but recent research done has also shown evidence that bacterial pathogens may be jumping between tick species. To further study the presence of these bacterial diseases and their transfer between species, tick specimens were collected in Hall County, NE. Previous research on *A. americanum* and *D. variabilis* has been focused on Buffalo and Dawson Counties, while Hall County lies just east of Buffalo County and extends the range of the study. During the summer 2021, 431 ticks were collected, identified, and DNA extracted. Within these specimens, two invasive tick species, the Gulf coast tick and Black legged tick were collected, underlining the concern of new tick-borne disease in Central Nebraska. Future research will focus on the analysis of positive bacterial DNA present in the samples via multi-plex PCR and DNA sequencing.

DISCOVERING A NOVEL PROTEIN-PROTEIN BINDING MECHANISM: THE PCNA AND CAF-1 INTERACTION

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The accurate replication of DNA and the proper packaging of newly synthesized DNA into nucleosomes are two crucial processes for maintaining genomic stability. Nucleosome assembly occurs when the DNA behind the replication fork is immediately wrapped around an octamer of histone proteins, initiating the process of DNA packaging. This assembly of nucleosomes determines the expression or silencing of genes and disruptions in this process can lead to features of cancer. The interaction between two proteins, proliferating cell nuclear antigen (PCNA) and chromatin assembly factor 1 (CAF-1), is essential for this process of replication-coupled nucleosome assembly. PCNA is involved in DNA replication and the recruitment of over 200 proteins to the replication fork. All proteins that interact with PCNA, including CAF-1, contain a consensus PCNA-interacting peptide (PIP) motif. CAF-1 is a histone chaperone protein that is recruited to the replication fork by PCNA and deposits histone proteins onto DNA to initiate the transition from DNA replication to nucleosome assembly. However, the precise mechanism of interaction between PCNA and CAF-1 remains unclear. This project elucidates the interaction between PCNA and CAF-1 at the structural level using X-ray crystallography. We have solved the structure of a complex of PCNA and CAF-1 to a resolution of 2.6 Angstroms that indicates a novel binding mechanism and provides insight about how PCNA may differentiate between proteins at the replication fork.

JUMPING SPECIES: SPILLING THE BEANS ON THE NEXT EPIDEMIC

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Dermacentor variabilis is the primary native tick species in Nebraska and a vector of intracellular pathogens, including several spotted fever group rickettsia and *Francisella tularensis*. Our objective was to survey female *D. variabilis* ticks collected along the Platte River in south-central Nebraska during the 2021 tick season to determine the bacterial pathogen prevalence. Total DNA was extracted from 332 female ticks for PCR analysis and confirmation of pathogen identity using amplicon sequencing. Out of 332 females, 41% (139) tested negatives to the pathogens. The presumptive positives consisted of 30% (102) *Rickettsia amblyommatis*, 2% (8) *Ehrlichia chaffeensis*, 6% (23) *Rickettsia montanensis*, 1% (4) *E. chaffeensis* and *Rickettsia amblyommatis*, 1% (2) *F. tularensis,* and *Rickettsia rickettsii* was not detected. This increase in *R. amblyommatis* may be due to increased overlap of *Amblyomma americanum* and native *D. variabilis*. Higher concentrations of *A. americanum* have been collected each year since 2016. This information indicated that there will be an increase in clinical cases of tick spotted fever disease.

PSYCHOPHARMACEUTICAL IMPACT ON STEROL SYNTHESIS IN DEVELOPMENT

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Genetic mutations in sterol synthesis enzymes are characterized by elevated 7-DHC, reduced cholesterol, reduced desmosterol, and altered acylcarnitine levels. Recently, our collaborators demonstrated that antipsychotics, antidepressants, and antiarrhythmics alter the sterol composition of neurons and astrocytes. These drugs also caused an increase in 7-DHC and a reduction in desmosterol levels. Given the prevalence of neurological disorders associated with developmental deficiencies, novel *in vivo* model systems are needed to improve the understanding of how commonly prescribed drugs impact fetal body and nervous system development. Zebrafish are ideal for screening pharmaceutical effects on vertebrate development. Zebrafish and humans express many of the same genes needed for sterol synthesis. The zebrafish model was utilized to test the hypothesis that exposure to pharmaceuticals will alter cholesterol biosynthesis and acylcarnitine levels and disrupt whole body and brain development resulting in abnormal behavior. Wildtype zebrafish were treated with the commonly prescribed antipsychotic cariprazine or AY9944, a known inhibitor of DHCR7 that is used to recapitulate phenotypes of Smith-Lemli-Opitz syndrome, a disorder brought about by mutations in the DHCR7 gene. Vehicle-treated fish were used as controls. Drug treatments of 1 and 10 µM were applied 3 days post fertilization until 5 days post fertilization (dpf). Endogenous cholesterol synthesis begins at 4dpf in zebrafish. Zebrafish were assessed for sterol synthesis, morphology, protein and RNA expression, neuronal network activity, and behavior at 5dpf. Exposure to cariprazine and AY9944 led to a significant increase in 7-DHC levels in comparison to control-treated zebrafish. Morphometric analyses demonstrated significant differences between the larval eye width, rump length, and standard larval length between the groups. Significant differences in behavior between the treated and control groups were observed using the Zebrabox imaging system. These data suggest that commonly prescribed pharmaceuticals may have a significant impact on fetal development and brain function leading to abnormal behavior.

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COMPARATIVE ANALYSIS OF THE STRUCTURAL DYNAMICS OF THE DOPPEL PROTEIN AND THE C-TERMINUS OF THE CELLULAR PRION PROTEIN

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The Doppel protein is the closest related protein on the phylogenetic tree to the prion protein. While the misfolding and aggregation of the prion protein is the hallmark of prion diseases, there is no reported evidence of an equivalent pathological process for the Doppel protein. Although the two proteins share only 25% sequence similarity, the folded C-terminus of the prion protein exhibits a topology similar to the Doppel protein. Even with the similar topology, previous studies suggest that the Doppel protein has a much higher energy barrier against misfolding than the prion protein. However, the factors that mold the energy barrier remain to be elucidated. Our goal is to decipher the role of the structural dynamics of the native fold on shaping the misfolding energy barrier of each protein. Understanding the driving forces that stabilize similar native topologies will provide insight into subtle interactions that may trigger pathological misfolding in the prion protein. To perform a comparative analysis of the structural dynamics of the proteins, we used normal mode analysis, a computational technique that mimics the large and collective motions of proteins in the native fold. Our preliminary results indicate that the pattern of backbone local mobility of both proteins is similar: a flexible α-helix 1, and a somewhat rigid cluster that includes the β-sheets and α-helices 2 and 3. We also observed that the main modes of deformations are qualitatively similar between the two proteins. In the presentation, we will discuss the key features of the residue connectivity that determine the common topology, and will propose target druggable residue interactions that may prevent prion protein misfolding.

CHARACTERIZING *BORRELIA BURGDORFERI*'S RESPONSES TO PH CHANGES

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Borellia burdgorferi, a causative agent of Lyme disease, is transmitted to humans by its tick vector, *Ixodes scapularis*. The CDC estimates there are 476,000 cases of Lyme disease in the United States per year, which will continue increasing as climate change is contributing to an ever-expanded range of habitat for *I. scapularis* ticks. Clinical symptoms range from fever, chills, fatigue, erythema migrans, and potentially facial palsy and heart palpitations if left untreated. Lyme disease is typically treated with antibiotics, but some patients experience symptoms after treatment leading them to be diagnosed with Post-Treatment Lyme disease syndrome which causes debilitating symptoms, including chronic pain, fatigue, and difficulty thinking. As there is no vaccine for Lyme disease, and because Lyme disease is becoming more common, it is crucial to understand the enzootic cycle of the bacteria and the signals used to complete its infectious cycle in order to create a vaccine or to develop more specific treatment options. *B. burgdorferi's* infectious cycle depends on environmental factors to differentiate between its tick and mammalian host such as changes in temperature, pH, carbon dioxide levels, and nutrient availability. When it transitions between hosts, it must adapt to a change in pH from a mammalian pH of 7.6 to a tick pH of 6.8, yet, during this transition *B.burgdorferi* also upregulates mammalian genes. The shift in pH provides relevant cues for gene and protein regulation and is commonly researched within laboratories. It is unknown whether the change in gene regulation and subsequent protein production is dependent on a directional change in pH or the delta pH. In the following study, we tested our hypothesis that gene regulation is dependent on the directional change in pH with distinctive transcriptional and translational expression levels. We hypothesize we will only see translational and transcriptional expression due to a directional change in pH from pH 7.6 to pH 6.8 and not vice versa. This experiment was carried out by analyzing transcriptional levels using RT-qPCR and translational expression using Western Blots.

COMPUTER SIMULATION OF COST AND BENEFITS OF ROBOTIC VS TRADITIONAL SURGERIES

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Robotic assisted surgeries are starting to become the better option over open laparoscopic procedures. Due to many benefits like shorter hospital stay, less recovery time, smaller incisions, less blood loss, and more, Surgeons and doctors can see more patients and operate more efficiently to provide the best outcome for the patient. With traditional laparoscopic open procedures, the opportunity for more error and a longer operation puts more stress on both the surgeon and the patient physically and mentally. While cost may be a factor weighing on making the switch to robotic assisted surgeries, it can also be a solution for hospitals to generate more money and increase the number of patients they treat and operate on to live a healthier life. Through this computer simulated model I mapped out the benefits and outcomes of using robotic assisted surgery procedures over traditional laparoscopic surgery.

IMPLEMENTATION OF 3D DORSAL ROOT GANGLION EXPLANT CULTURE PLATFORM FOR SCREENING CHONDROITIN SULFATE NEURO-INHIBITORY MIRCOPARTICLES

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Low back pain affects up to 80% of the population at some point in their lifetime[1], with disc degeneration being highly correlated with low back pain[1]. The healthy intervertebral disc is predominantly aneural[2]; however, in at least 40% of chronic low back pain cases, patients 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 and avoiding nerve regrowth could alleviate low back pain. Chondroitin Sulfate (CS) hydrogels have displayed neuro-inhibitory properties to DRG neurites in vitro[7]. The use of chondroitin sulfate microparticles (CS MPs) could include drug delivery applications while preventing nerve regrowth. Our lab has developed methacrylate CS-A (MACS-A) MPs to deliver antioxidants therapeutics. However, neuro-inhibitory properties of MACS-A in MP form have not been investigated yet. To test the neuro-inhibitory properties of CS MPs in vitro, DRG explants were embedded in a 3D hydrogel (growth gel) and neurite growth into an adjacent test gel was measured[7]; however, gaps would form between the growth and test gels due to separate crosslinking of the gels. This drawback propitiated the need to develop an improved platform. The 3D hydrogels used for DRG explant culture consisted of methacrylated hyaluronic acid (MAHA) (1.25 mg/ml), collagen type I (4.5 mg/ml), 1xPBS and MilliQH_2O. An alternative set-up consisted of MPs injected using 23G needle syringes before and after crosslinking the MAHA gels. The distribution of the injected MPs in hydrogels were analyzed and preliminary results revealed a more homogenous distribution when MPs were injected before crosslinking MAHA gels. However, both alternatives showed poor precision when injecting MPs in gels and an inability to visualize the boundary between the test gel (with MPs) and the growth gel. The conjugation of RGD-Fluorescein isothiocyanate (RGD-FITC), a widely used fluorescent label to attach to proteins via the amine group[8-9], was implemented to fabricate fluorescence MAHA hydrogels after modification with EDC-NHS chemistry. Preliminary results showed significantly higher fluorescence in MAHA(RGD-FITC) solution and gels compared to MAHA (only) gels. These results suggest MPs in MAHA(RGD-FITC) gels could be used to test neuro-inhibitory properties of CS MPs. Future steps include validating growth of DRG neurites in MAHA(RGD-FITC) gels and further development of an alternative gel-in-gel method to test neuro-inhibition of CS MPs in a 3D hydrogel DRG explant culture.

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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. 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 expression of 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 highly prevalent in bacteria, determined to be in more than 400 strains of gram-positive bacteria and 5 strains of gram-negative bacteria. Due to its prevalence and its ability to control cell viability, the *glmS* riboswitch is a potential target for new antibiotics. This project aims 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 near 56 mM for *B. subtilis* and 21 mM for *S. aureus*. Verification of the mechanism of the interaction with the *glmS* riboswitch is being performed using RT-PCR and future studies will investigate the effects of L-Serine on mutant strains of *B. subtilis* and *S. aureus*.

NOVEL HUMAN LONG NON-CODING RNAS MODULATE IONIZING RADIATION-INDUCED NEUROINFLAMMATION

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Exposure of the central nervous system (CNS) to ionizing radiation produces an inflammatory response that may result in neurotoxicity. Increased understanding of the regulatory factors controlling the inflammatory response and direct neurotoxicity in response to ionizing radiation may aid in preventing inflammation in the CNS. Long non-coding RNAs (lncRNAs) are a class of RNA molecules that regulate gene expression via interactions with RNA-binding proteins, such as transcription factors. While many lncRNAs have been identified, the function of few has been elucidated, and thus lncRNAs represent new potential therapeutic targets to prevent inflammation in the CNS. We have previously identified a novel murine lncRNA, Nostrill, that regulates neuroinflammation via modulating the response of microglia to ionizing radiation. The hypothesis driving these translational studies is that human orthologs of lncRNA Nostrill are induced in response to ionizing radiation and regulate neuroinflammation in a human neuronal cell line. Ionizing radiation was delivered using a Faxitron CellRad irradiator with varying doses of radiation to the human SH-SY5Y neuroblastoma cell line. Knockdown of select lncRNAs was performed via transfection with siRNA at 60 nM utilizing Lipofectamine RNAiMAX. A non-specific scrambled siRNA served as a control. Initial studies identified a dose-response relationship between the dose of ionizing radiation (0.1 Gy, 1 Gy, 10 Gy) delivered to cells and the fold change induction of human lncRNAs. Time-course analysis (2h, 8h, 24h, 48h) revealed differential responses of the three different lncRNA candidates, suggesting the possibility of unique roles in the response to ionizing radiation. Functional studies were performed with knockdown of lncRNA targets prior to exposure to ionizing radiation and demonstrated that knockdown of two novel human lncRNAs significantly reduced ionizing radiation-induced expression of the inflammatory mediators Ccl5 and iNOS. Further studies are ongoing to investigate the molecular mechanism of this regulation and assess biological relevance based on neurotoxicity in co-culture assays.

LAUGHTER: THE BEST MEDICINE

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Laughter is starting to become known as a strong medication. Aside from laughter's ability to draw individuals together, laughter provides many benefits such as strengthening the immune system, diminishing pain, release of endorphins, relaxing the entire body, and protecting the heart. No medication can alleviate pain and bring the body back into balance as quickly as laughing can. Traditional medications can induce a variety of symptoms. Alternatively, laughter is a natural resource often neglected. While duration and intensity may be a factor weighing on laughter's efficiency, a simple giggle can be a quick method for automatic relaxation. Through this computer simulated model. I mapped out the benefits and outcomes of utilizing laughter over prescription medications.

A COMPUTER MODEL OF PHYSICIAN SHORTAGE IN THE UNITED STATES

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The Association of American Medical Colleges in 2020 projected that by 2034 the United States will have a shortage of roughly 100,000 physicians. Nebraska, only having two medical schools in the whole state, embraces a unique problem with the retention of these physicians. Between potential medical students attending medical schools not in Nebraska and the enrollment of non-Nebraska residents into those programs, physician retention is of concern. Using Stella software, we have been able to map out possible areas of improvement in order to help combat the shortage of physicians seen in Nebraska and across the whole United States.

POLYAMINE-INDUCED CONFORMATIONAL CHANGES IN THE HUMAN OAZ-PK RNA

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Regulation of gene expression in cellular metabolism exists in numerous modalities. Riboswitches are segments of noncoding RNA that undergo a conformational change upon binding a specific metabolite and then regulate gene expression of the same cognate metabolite. While riboswitch-mediated feedback regulation is widely studied in bacteria, there remain opportunities for further riboswitch research in mammals. The Soukup lab 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. The ornithine decarboxylase enzyme (ODC) is a necessary component of polyamine synthesis and is negatively regulated by ornithine decarboxylase antizyme (OAZ) in mice, humans, and other eukaryotic organisms. The OAZ protein is further regulated by polyamine-enhanced translational frameshifting of the OAZ mRNA—specifically, a pseudoknot (PK) in the human OAZ RNA may be involved. Previous work in the lab strongly suggests the presence of a riboswitch in the mouse OAZ RNA as the RNA specifically binds to one polyamine and undergoes polyamine-induced conformational changes. Additionally, previous work with the human OAZ-PK RNA suggests the presence of a riboswitch through specificity of polyamine binding of spermine. My preliminary data suggests concentration-dependent conformational changes of the OAZ-PK RNA induced by spermine. Future studies will use Selective 2'-Hydroxyl Acylation analyzed by Primer Extension (SHAPE) to further investigate polyamine-induced conformational changes, but it is believed that the ability to target riboswitches and regulate metabolic pathways provide a future for novel antibiological and anticancer therapeutics.

INCREASED PERSISTER FORMATION IN *STAPHYLOCOCCUS AUREUS* LEADS TO INCREASED SURVIVAL WITHIN A HOST

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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 major concern with *S. aureus* is the possibility of chronic recurring infections or relapse in indwelling device biofilm mediated infections. One potential reason for this is the presence of persister cells - a dormant type of cell that exhibits high tolerance for antibiotics. Recent studies have shown a connection between low intracellular ATP/low membrane potential and persister cell formation. Specifically, this decrease in ATP, and therefore the increase in persister cell formation, comes from an interrupted tricarboxylic acid (TCA) cycle. However, persister cells' role in pathogenesis remains unclear. To investigate this, a biofilm mediated catheter model was performed with C57Bl/6 male and female mice. Results showed female mice were trending towards more frequently clearing HG003 wild type *S. aureus* compared to *fumC* (TCA cycle gene) knockout *S. aureus.* To investigate this trend, a biofilm kill assay was performed. In this assay, the *fumC* knockout biofilm exhibited similar survival compared to HG003 *S. aureus* biofilm, whereas in planktonic cultures the *fumC* knockout exhibits increased survival. This gives support for only a trending difference in the mouse model and gives footing for the hypothesis that biofilms are made of persister cells. To investigate this hypothesis, we looked at expression of a persister cell marker within a HG003 biofilm. Increased *cap5A* (a known persister cell marker) expression was shown in a mature biofilm compared to an immature biofilm. Persister cells were previously shown to have reduced membrane potential, therefore membrane potential in biofilms was examined. Cells grown in a biofilm exhibited a 22-fold increase in the number of cells exhibiting low membrane potential compared to planktonically grown cells. These results may help uncover why methicillin susceptible *S. aureus* may be difficult to treat in a clinical setting, especially during an indwelling device biofilm mediated infection.

ANDROGENS NEGATIVELY REGULATE THE ALLERGIC IMMUNE RESPONSE TO PEANUT

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Peanut (PN) allergy is an ongoing public health problem. Knowledge about the allergic mechanism has increased in recent years; however, the underlying factors that influence the development of PN allergy are not well understood. Many different diseases show a sex bias, including allergic asthma. Previous PubMed meta-analysis on published food allergy prevalence shows that there is a female sex bias in adulthood. This evidence suggests the role of androgens in suppressing allergic immune responses to food allergens. This project aims to determine if such a sex bias exists in PN allergy using an established PN sensitization mouse model. We found a sex difference, with WT females developing stronger allergic responses to PN than their male counterparts. Furthermore, the effect of androgen signaling in offering protection against PN allergy was examined using testicular feminization mutant (Tfm) male mice that are unable to signal through the androgen receptor (AR). Tfm mice developed allergic responses to PN significantly worse that WT males. WT mice were gonadectomized and implanted with capsules containing opposite sex hormone (e.g. β-estradiol in males and dihydrotestosterone in females). We were not able to recapitulate the protection against PN allergy using this experimental strategy, suggesting that gonad-specific factors independent of the hormones being replaced are driving androgen-specific protection. Overall, this data strongly suggests that sex differences exist in the development of PN allergy, and these differences are driven by androgens.

IMPACT OF HELPER ILCS AND ANTI-PD1 SUPPLEMENTATION IN NK-CELL MEDIATED CANCER CELL KILLING

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Immunotherapy, the process of augmenting a person's own immune system to fight off diseases - including malignancies, is becoming prominent in cancer medicine. Innate lymphoid cells (ILCs) act as the body's innate immune counterpart to antigen-specific T cells: while they share functions and phenotypes with their T cell counterparts, ILCs lack antigen receptors and instead respond largely to tissue signaling. Thus, ILCs can mount a faster, broader-spectrum response than T cells. Natural killer (NK) cells, recently classified as an ILC subtype, are recognized immunotherapeutic effectors known for their heightened killing capacity through both direct killing and antibody-dependent cellular cytotoxicity (ADCC). In ADCC, antigens are used to induce recognition of target cells by antibodies that also bind to NK effector cells. Helper ILCs (non-NK ILC1s, ILC2s, and ILC3s) have varied roles in cancer. They are often dysregulated in cancer microenvironments, with impaired cytokine production that allows cancerous cells to avoid immune detection. However, ILCs with healthy cytokine expression may have the capacity to help, rather than block, cancer killing. Additionally, blockade of the programmed death 1 (PD1) inhibitory receptor with an anti-PD1 antibody (α-PD1) has been clinically verified in combatting immune exhaustion and reactivate T cells to kill multiple cancer modalities. Current literature suggests that α-PD1 treatment may show comparable results on NK cell-mediated ADCC. The Denton Immunobiology at UNO is currently testing combination immunotherapeutic strategies to augment ADCC killing. We propose that the addition of healthy ILCs and/or anti-PD1 antibody to our NK cell-mediated ADCC assay will increase NK cell killing of the target B-cell lymphoma cells investigated. Results to date will be presented.

IMPACT OF HER2 EXPRESSION AND HYPOXIC CULTURE CONDITIONS ON MITOCHONDRIAL ENERGETICS *IN VITRO*

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With the onset of cancer comes several phenotypic changes that distinguish the tissue within tumors from healthy tissue. From the structural remodeling of the extracellular matrix, to changes in mitochondrial function reflecting the hypoxic environment of a tumor, these alterations are necessary to support cancerous growth and to promote metastasis. Past research has been successful in detecting differences in energy utilization in a Squamous Cell Carcinoma (SCC) line comparing a primary (low HER2) tumor to a secondary, recurrent (high HER2) tumor[1]. Our current study examines the relationship between oxygen availability, HER2 expression, and mitochondrial treatment -uncoupling and inhibition- across three cancer cell lines. We quantified changes in NADH bound fraction and NADH intensity as explained by changes in culture oxygenation, HER2 inhibition by AG825, and mitochondrial treatments. Statistical analysis was performed using a type III factorial ANOVA. In general, we observed that the inhibition of HER2 reduced the bound fraction and increased the concentration of NAD(P)H. In addition, reduced response to electron transport chain (ETC) inhibition and uncoupling was observed. Particularly, cells cultured under hypoxic (2% O_2) conditions exhibited these differences to a greater degree compared to those under normoxic oxygenation (21% O_2). These results suggest an interaction between HER2 expression, ETC regulation, and glycolysis. Our findings suggest that cell culture experiments performed at atmospheric oxygen do not reflect the cellular energetics typically observed *in vivo*.

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METABOLIC IMAGING BY NAD(P)H PHASOR-FLIM AND SHG AS A NON-INVASIVE DIAGNOSTIC TECHNIQUE FOR SKIN CANCER

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Compared to healthy tissue, cancer tissue demands greater energy production to support increased proliferation. This metabolic shift can be detected in vivo using NAD(P)H phasor-Fluorescence Lifetime Imaging Microscopy (FLIM). We utilized NAD(P)H phasor-FLIM imaging to directly measure changes in NAD(P)H fluorescence intensity and NAD(P)H bound fraction between UVA-treated and sham-treated SKH1 mice. We also measured collagen within the skin by fluorescence and second harmonic generation (SHG) imaging to assess architectural shifts indicative of tumorigenesis. During our one-year longitudinal study, we correlated changes in NAD(P)H and collagen with visual observations of UVA-induced papillomas. These observations were then verified with standard histological and immunofluorescence imaging. Our data demonstrates that UVA-treated SKH1 mice show a decrease in the NAD(P)H bound fraction compared to sham-treated mice. Ultimately, our goal is to demonstrate the diagnostic values of this technique as a non-invasive optical biopsy for skin cancer.

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DETECTION OF NOVEL REPEAT REGIONS WITHIN THE *TOXOPLASMA GONDII* GENOME FOR CLINICAL DIAGNOSIS

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Sensitive, specific, and efficient diagnostics aid in the accurate detection of infectious diseases, which can be vital to ensure patients receive appropriate care. The current diagnostic methods of *Toxoplasma gondii* include serological testing and polymerase chain reactions (PCR), which have comparable accuracy. Currently, Rep529, a 200 to 300-fold repeated DNA region, is used to detect *T. gondii* by quantitative PCR, but as a diagnostic marker, there is variability in the sensitivity and accuracy of the detection against different strains. A novel PCR diagnostic marker that is more sensitive than the current clinical diagnostic of Rep529 would enhance detection of lower parasite amounts in the patient and may be more accurate against strains that diverge from known isolates. Maintaining specificity to *Toxoplasma gondii* ensures against false detection of the host and other human pathogens. Using a novel bioinformatics workflow, three novel regions of the *T. gondii* genome were identified and investigated to detect the pathogen at a more specific and sensitive threshold than Rep529. Now, *in vitro* laboratory techniques are showing, quantitatively, that all three sequences are more robust than the current state of the art.

STAPHYLOCOCCUS AUREUS PERSISTERS EXHIBIT INCREASED SURVIVAL TO COMPONENTS OF THE INNATE IMMUNE SYSTEM

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Staphylococcus aureus is an opportunist pathogen that is the leading cause of nosocomial infections. These infections are often associated with foreign devices and cause a variety of infections ranging from sepsis, osteomyelitis, infective endocarditis, and osteoarticular infections. While infections mediated by antibiotic resistant organisms remain a concern, recalcitrant and relapsing infections are often caused by drug-susceptible pathogens. This phenomenon is thought to be caused by persister cells, which are a subset of dormant-like cells that survive antibiotic treatment. Persister cell formation was previously shown to be dependent on reduced tricarboxylic acid cycle (TCA) activity, resulting in lower intracellular ATP. Interruption of the *fumC* gene in the TCA cycle increases the number of persister cells, resulting in better survival to antibiotic treatment. However, little is known about the interaction between persister cells and the innate immune system. Previous work demonstrated that the *fumC* knockout survived better when challenged with antimicrobial peptides and within a *Drosophila melanogaster* model of infection. Based on these findings, we hypothesized that the *fumC* knockout will survive better to other components of innate immunity. We first investigated survival of the *fumC* knockout within a macrophage. The *fumC* knockout had an increased survival compared to wild type within a macrophage 18 hours post infection (multiplicity of infection of 10). To determine the underlying mechanism for this phenomenon, we measured the intracellular levels of two known antimicrobial compounds, reactive nitrogen species (RNS) and reactive oxygen species (ROS). We found RNS and ROS levels were similar between macrophages infected with the *fumC* knockout and macrophages infected with wild type *S. aureus.* We monitored the growth of the *fumC* knockout in the presence of RNS and ROS. In the presence of 10 mM of paraquat or 1 mM of $NaNO_2$, the *fumC* knockout exhibited an increased growth yield compared to HG003 wild type. To further understand this interaction, we added lethal concentrations of these same antimicrobial agents and found that the *fumC* knockout had increased survival. These results indicate that the *fumC* knockout and HG003wild type illicit a similar immune response within a macrophage, but the *fumC* knockout is better equipped to survive that environment, thus revealing the possible mechanism of persister survival within a host.

ADVANCING RADIOIMMUNOTHERAPY FOR BRAIN TUMORS USING *IN VITRO* ASSAYS

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Purpose: Glioblastoma is the most common and malignant primary brain tumor. Due to factors including resistance to treatment, local invasion, and high risk of recurrence, glioblastoma patient prognoses are often dismal, with median survival around 15 months. The current standard of care consists of radiation therapy and concurrent or adjuvant chemotherapy with temozolomide (TMZ). However, patient survival has only marginally improved, sounding a call for improved therapy for glioblastoma. More recently, triumphs using anticancer agents acting as immune-checkpoint inhibitors against cancers including metastatic melanoma and non-small-cell lung cancer (NSCLC) have garnered interest toward applying these agents to glioblastoma. One such agent, durvalumab, is undergoing phase I and II clinical trials in radioimmunotherapy for recurrent glioblastoma and high-grade glioma. However, agents showing high therapeutic potential may also carry unforeseen effects which may affect treatment outcomes. The purpose of this work is to bring these agents used in radioimmunotherapy applications to *in vitro* systems, where some effects may be better observed, with the goal of developing effective combination modalities for glioblastoma, which has a 5-10% 5-year survival rate. **Methods:** Using a Faxitron CellRad cell irradiator and a commercially-available Electric Cell Impedance Sensor (ECIS), we quantified cell migration following the combination of radiotherapy and chemotherapy with temozolomide (TMZ), and now focus on the combination of radiotherapy and immunotherapy with durvalumab, a PD-L1 immune checkpoint inhibitor. **Results:** Preliminary results show that irradiated T98G and U87 MG cells (glioblastoma) migrate significantly more ($p<0.01$) than untreated cells in the first 20-40 hours posttreatment, and that the addition of temozolomide further alters cell migration and attachment. Shifting focus toward durvalumab in radioimmunotherapy, results in ECIS, cell morphometry, and clonogenic assays will be presented. **Conclusion:** Our preliminary results suggest that ECIS can be used to explore effects of immunotherapy and radiotherapy on cell migration, aiding in the determination of effective therapeutic windows for glioblastoma while detecting changes to cell behavior.

THE ROLE OF MOMP AS A TARGET FOR AN mRNA *CHLAMYDIA* VACCINE.

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Chlamydia trachomatis is the most common STI reported in the United States and is an infection of high prevalence in many developing countries. Critically, infected mothers often contaminate the eyes of their children during birth, resulting in trachoma, the leading cause of preventable blindness. Incidences of trachoma are predominantly reported in Sub-Saharan Africa. While antibiotics can cure a current chlamydia infection, if not readily diagnosed or provided, treatment will not prevent any long-lasting damage as a result of infection. Developing a vaccine for *Chlamydia trachomatis* remains a high priority. This pursuit is complicated by the fact that chlamydia is strictly a parasitic organism, so manipulation of the organism is difficult. In recent years, Major Outer Membrane Protein (MOMP), a surface protein of vaccine interest was identified. MOMP is vital in chlamydial infection as it acts as a structural protein, with a possible role in cyto-adhesin. In addition, MOMP is found in both elementary bodies (EBs) and reticulate bodies (RB) of *C. trachomatis,* two forms of manifestation during human cell infection. The focus of this research is to begin to explore MOMP mRNA as a possible method of a *Chlamydia trachomatis* vaccine. We have successfully cloned the gene, confirmed a viable open reading frame, and conducted transfections into HEK-293 cells. Preliminary analysis of MOMP expression in this human cell line is underway. This publication was made possible by grants from the National Center for Research Resources (5P20RR016469) and the National Institute for General Medical Science (NIGMS) (8P20GM103427), 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.

VIRTUAL SCREENING OF NATURAL PRODUCT PYRUVATE DEHYDROGENASE KINASE INHIBITORS

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Pyruvate dehydrogenase kinase (PDK) regulates the activity of the pyruvate dehydrogenase complex (PDC), an enzyme that connects glycolysis to the TCA cycle, by inactivating the complex by phosphorylation. There are four isozymes (PDK1-4) differing in expression depending on tissue. The overexpression of these isozymes is associated with a variety of diseases including several cancers, heart disease, and type-2 diabetes. PDKs bind the lipoyl domains of the E2 subunit of PDC. Therefore, identifying compounds that interfere with this interaction is a reasonable strategy to inhibit PDK binding. While inhibitors that target this domain, such as AZD7545, are available, there is no FDA approved inhibitor for PDK. The ability to virtually screen large sets of compounds to a target protein offers a fast and inexpensive method to search for new therapeutics. 224,205 naturally occurring compounds were obtained from the ZINC15 database and used to generate 353,589 structures by varying isoforms. An advantage of the ZINC15 database, is that it provides convenient links to commercial availability for experimental studies. The compounds were screened by Lipinski's rule and docked to the lipoamide binding site of PDK2 with the Glide docking program, within the Schrödinger software suite, using three successively more accurate algorithms where the top 10% from one phase was inputted into the next. To obtain more accurate estimates of binding affinity, the molecular mechanics-generalized Born surface area (MM-GBSA) calculation was implemented post-docking. To assess relative binding affinity to a well-known PDK inhibitor, AZD7545 was docked and the MM-GBSA was calculated at -62.81 (kcal/mol). Several natural products have a lower or stronger calculated binding affinity than AZD7545, the best of which is -90.47 (kcal/mol). Therefore, it is reasonable that these compounds will be potentially potent inhibitors, which are to be tested via future experimental assays.

MEASURING RESPONSE TO AG825 TREATMENT AND CULTURE CONDITIONS ACROSS MULTIPLE CANCER CELL LINES VIA NAD(P)H PHASOR-FLIM

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In vitro cancer cell experiments are often conducted under atmospheric oxygen concentrations; however, this may not accurately depict tumors which are typically hypoxic. To emulate *in vivo* oxygen concentrations, we cultured squamous cell carcinoma (SCC) under chronic hypoxic conditions and measured changes in NAD(P)H fluorescence using phasor fluorescent lifetime imaging microscopy (FLIM). We hypothesized that NAD(P)H bound fraction, intensity, and utilization of the electron transport chain (ETC) would change under prolonged hypoxia. We also evaluated the impact of HER2 overexpression by inhibiting HER2 with AG825. For comparison, we repeated the study with well-established breast cancer cell lines. We analyzed our data using a type III factorial ANOVA. Our data demonstrated that the cell lines had a reduced NAD(P)H bound fraction, intensity, and reduced utilization of the ETC when grown in hypoxic conditions. Cell lines which overexpressed HER2 were less affected by a hypoxic environment. Our findings suggest that cancer cells cultured in a hypoxic environment had altered mitochondrial function compared to the same cells cultured under atmospheric oxygen concentrations. Our methods demonstrate that phasor FLIM imaging of NAD(P)H can be used to detect changes in mitochondrial function in response to growth factor signaling and environmental conditions.

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NF-κB SIGNALING IN TRIPLE NEGATIVE BREAST CANCER

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Triple negative breast cancer is an extremely aggressive malignancy, especially known for affecting younger women and being caught in later stages of the malignancy. The combination of being caught late as well as being aggressive in proliferation and metastasis of the cancer typically leads to a poor prognosis. Patients who are successfully treated for this cancer also tend to see an early recurrence of the cancer. The cancer metastasizes via the bloodstream early to the liver, lungs, and nervous system. Triple negative breast cancer also lacks diagnostic markers as well as potential therapeutic targets such as hormone receptors and the HER2 growth factor receptor. Chemotherapy remains the top way to treat triple-negative breast cancer, although immunotherapy is being heavily investigated. Nuclear factor – kappa B (NF-κB) is a transcription factor that participates in signaling pathway to upregulate cell proliferation, cell growth, and angiogenesis in cancer cells. Upregulation of the NF-κB pathway is seen in triple negative breast cancer cells and may be the pathway driving cell growth and metastasis.

Curcumin is a polyphenol that is currently being investigated for its antioxidants, antiviral, antimicrobial and anti-inflammatory properties. Curcumin has been reported to reduce inflammation in cancers and to return regulation of proteins and of the cell to a more normal state. Curcumin can be used for many molecular targets such as transcription factors, growth factors, receptors, proliferative proteins, and apoptotic proteins. Curcumin is thought to suppress NF-κB via inhibiting IKK to keep it from phosphorylating IκB. Phosphorylation of IκB causes the destruction of IκB and the release and activation of NF-κB. The purpose of this research is to investigate the effects of curcumin on the NF-kB signaling pathway in triple-negative breast cancer. Previous work in the lab has demonstrated that curcumin causes apoptosis of MDA-MD-231 triple negative breast cancer cells within 48 hours of treatment. We are currently investigating whether apoptosis is caused by inhibition of the NF-κB pathway. Western blots have demonstrated an increase in IκB in cells treated with curcumin; however, an immunoprecipitation assay did not show an increase in binding of NF-κB to IκB after curcumin treatment. Further research is being conducted to determine if IκB is phosphorylated by IKK in cells treated with curcumin. Curcumin or other therapies that target the NF-κB pathway could be a potential treatment for triple-negative breast cancer cells.

STRUCTURAL AND FUNCTIONAL ANALYSIS OF *CRASSOSTREA GIGAS* OAZ-PK RNA

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A riboswitch is a non-coding RNA sequence that regulates the expression of a downstream gene when it is bound to a metabolite. When the riboswitch RNA interacts with a specific metabolite, it undergoes a conformational change, which leads to a change in gene expression. Ultimately, gene expression is altered so as to inhibit the production of this same metabolite within its metabolic pathway. The Soukup lab is currently researching a potential mammalian riboswitch in the Ornithine Decarboxylase Antizyme pseudoknot (OAZ-PK) RNA segment. Previous work in the lab revealed that OAZ-PK RNA in mouse undergoes conformational changes in the presence of a specific polyamine. A polyamine is an organic compound that influences cell growth and differentiation. Since riboswitches have such a profound influence on metabolic pathways in bacteria, this provides an outlet for new antibiotic treatments. Identification of similar noncoding RNAs in eukaryotes will open up possibilities for novel antibiological agents. My project focuses on studying a potential riboswitch in *Crassostrea gigas*, a species of oyster. More specifically, I am performing In-Line Probing (ILP) experiments to analyze the secondary structural changes of this RNA segment when it interacts with various concentrations of natural and non-natural polyamines. Preliminary data from ILP experiments suggest that the OAZ-PK RNA in oyster is undergoing conformational changes in the presence of different concentrations of spermine. In the future, more ILP experiments will be performed, along with the use of Selective 22-Hydroxyl Acylation analyzed by Primer Extension (SHAPE) to further study the polyamine concentration-dependent conformational changes in OAZ-PK RNA.

POTENTIAL FOR VIRAL REPLICATION WITHIN THE BRAIN OF NORA VIRUS-INFECTED *DROSOPHILA MELANOGASTER*

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Nora virus (NV) was first described less than two decades ago when it was found to infect *Drosophila melanogaster.* It has since been found to infect a variety of insects. NV is a positive-sense, single-stranded picornavirus that is transmitted horizontally by the fecal-oral route. Since its discovery, viral replication appeared to be largely confined to the gut, and insects infected with NV did not show any obvious symptomology. Recently it was shown that NV infected *D. melanogaster* exhibit declines in geotaxis, viral nucleic acids can be isolated from the hemolymph, and viral small interfering RNAs can be isolated from the brains of NV infected flies. In light of this evidence we hypothesized that NV is capable of invading the nervous system, like other picornaviruses, to infect the brains of *D. melanogaster.* In the present study, we collected female adult flies from chronically infected Canton S laboratory stocks. At 5 to 7 days post-eclosion we removed the heads from the bodies in groups of 10-15 flies and extracted RNA. We amplified the NV *ORF1* by means of RT-PCR and confirmed the presence of NV in the heads of infected flies by gel electrophoresis. We also removed heads from bodies of 10-15 flies and extracted RNA at various time points over the course of adult infection. We are in the process of utilizing qRT-PC to compare the viral load between heads and bodies throughout the infection. We predict that viral load in the heads will follow a similar bimodal pattern, as seen in the body at large, though there might be some delay initially as the virus must travel from the gut to the hemolymph, before making its way to the nervous system. Finally, we are optimizing protocols to dissect the heads of infected flies and section them on the cryostat. We will use immunohistochemistry and confocal microscopy in an attempt to visualize NV within the brains of infected flies, to confirm viral replication within the brain. Given the importance of fruit flies to genetic and immunological research, it is necessary to study the intricacies of this endemic fruit fly virus that chronically infects laboratory stocks. The present study will further the understanding of NV replication over the course of infection, as well as explore the possibility for neuro-invasion by the virus in *D. melanogaster.*

MODULATION OF INTERFERON REGULATORY FACTOR 7 PRODUCTION AND ANTIVIRAL RESPONSE THROUGH LINCRNA-NOSTRILL IN MICROGLIA

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Multiple Sclerosis (MS) is an autoimmune disease that causes demyelination, inflammation, and axonal degeneration in the central nervous system (CNS). The exact mechanisms and cause of this disease are still largely unknown; however, leading theories suggest it may be caused by viral infection. Theiler's murine encephalomyelitis virus (TMEV) is a single-stranded RNA cardiovirus that is commonly used to model progressive forms of MS in mice. Microglia are glial cells in the CNS that can activate both innate inflammatory and adaptive immune responses resulting from infection. Long non-coding RNAs (lincRNAs) modulate diverse cellular processes and were recently discovered to play a key role in inflammation. LincRNAs are a type of RNA that are not transcribed into protein and are at least 200 nucleotides long. The role of lincRNAs in regulating inflammation in neurodegenerative disorders, such as MS, has yet to be fully explored. We have identified the lincRNA Nostrill whose expression is upregulated in both TMEV *in vivo* and *in vitro* model systems of progressive MS. We hypothesize that Nostrill plays a vital role in the modulation of the antiviral inflammatory process in microglia by associating with NF-kB and promoting the transcription of interferon regulatory factor 7 (Irf7) and the antiviral cytokine interferon-beta. To test our hypothesis *in vitro*, we infected a murine microglial cell line with the DA strain of TMEV. NF-kB inhibition and functional studies using the knockdown or overexpression of Nostrill were performed. Following infection, RNA or protein from microglia were isolated for RT-PCR or Western Blot analysis, respectively. Our results indicate that in the presence of NF-kB inhibitors, Nostrill, Irf7, and interferon-beta expression significantly decreased. Additionally, knockdown of Nostrill significantly increased TMEV viral load and overexpression significantly reduced TMEV viral load. Western blot analysis demonstrates that knockdown of Nostrill reduces IRF7 phosphorylation and localization to the nucleus while overexpression increases IRF7 phosphorylation and localization to the nucleus. Future RNA immunoprecipitation assays will investigate Nostrill's direct association with IRF7 and NF-kB. These preliminary studies suggest that Nostrill is an important lincRNA involved in regulating antiviral inflammatory responses in microglia. Understanding these mechanisms are likely to improve our understanding of how antiviral microglial responses contribute to the CNS degeneration diseases such as MS.

PRIMATE-SPECIFIC INTERFERON REGULATORY FACTOR 9 (PS-IRF9) AND ITS ROLE IN INTERFERON SIGNALING PATHWAYS

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Interferons (IFNs) consist of a large family of signaling proteins which function as key regulators of the innate immune system, and which also play a role in the regulation of cellular processes involved in various other pathologies. The binding of type I IFNs to their receptors and the subsequent formation of the IFN-receptor complex activates IFN-stimulated genes (ISGs), and it is through this transcriptional regulation and activation of ISGs that makes IFNs the most potent host defense mechanism against viruses and other pathogens. Primate-Specific Interferon Regulatory Factor 9 (PS-IRF9) has been identified as one among several transcriptional regulatory factors of IFNs and one which must serve a function integral to the processes involved in the innate immune system, given it has been evolutionarily conserved across primates. Previous research suggests that latent Epstein-Barr virus (EBV) cells are regulated by a select few Interferon Regulatory Factors, namely IRF2, 4, 5, 7, and 8. Preliminary data investigating the potential of PS-IRF9 as a functional regulator in EBV latency cells via Western Blot analysis has detected bands consistent with the known molecular weight of PS-IRF9. Additionally, previous research led by Dr. Zhang demonstrated that overexpression of PS-IRF9 inhibits IFN-induced STAT1 expression. We hypothesize that PS-IRF9 serves an essential function related to IFN's role in the innate immune system, particularly as a negative regulator of the IFN pathway. Further elucidation of the precise function and mechanism of this regulatory factor can provide insight into the vast complexities of innate immunity as well as the variations that exist across species.

ANALYSIS OF IMMUNE REGULATED GENE IN A *DROSOPHILA MELANOGASTER* MODEL OF PEANUT ALLERGY

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Peanut (PN) allergy is common and often life-threatening food allergy in the United States. Mice are traditionally used to study PN allergy, but this can be expensive and time-consuming. *Drosophila melanogaster,* on the other hand, have proven useful to study human diseases and disorders due to their similar genome while eliminating the issues encountered using mice. For these reasons and due to the ease of use and manipulation, *D. melanogaster* were chosen as the organism in which to analyze immune regulated genes possibly affected by exposure to PN. The genes that were picked were *Relish* (*rel*), *Cactus* (*cact*), *Dif*, and *Dorsal* (*dl*) because these are immune genes in the Toll pathway that have NF-kB homologs in humans that are activated in an allergic response. The control condition was exposure to 5% sucrose, while the experimental condition used to induce PN allergy was 5% sucrose + 5% PN flour. One hundred and fifty virgin *CantonS* NV+ (Nora virus positive) females each were put into eight-pint cages (4 for each condition). The females were aged for 3 days in the pint cages with regular food before being exposed to the two conditions. At day 3, the food vial was replaced with vials of cotton balls either soaked in 5% sucrose alone or with PN flour. Every 24 hours for 7 days, the vials were replaced with fresh solution, dead flies collected and counted, 10 live flies collected, and all flies frozen. All live samples were used to extract RNA to determine if the immune regulated genes were affected. qRT-PCR was performed on days 0 and 6 and found a significant upregulation of *Cactus* and a significant downregulation of *Dif*. There were no significant changes in the *Relish* or *Dorsal* genes. In addition, survival curve analysis showed that the addition of peanut had no effect on the survival rate of the fly species. This is the first demonstration that *D. melanogaster* elicits an immune response to PN exposure and possibly can be used as a model for PN allergy in the future.

CPTII DEFICIENCY AND THE EFFECTS ON BODY AND BRAIN DEVELOPMENT

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Long chain fatty acid (LCFA) catabolism via beta-oxidation functions as an alternative pathway to glucose, and in areas such as the brain, LCFA catabolism is prevalent during this developmental period. In LCFA catabolism, the carnitine shuttle protein carnitine palmitoyltransferase II (CPTII), facilitates the conversion of palmitoylcarnitine to palmitoyl-CoA. However, when there is a deficiency of CPTII protein, the disruption of LCFA catabolism leads to pathology characterized by neurodevelopmental abnormalities, muscle weakness, and reduced fatty acid oxidation. Work with our collaborators has recently confirmed CPTII deficiency in a proband diagnosed with schizophrenia. We are interested in the mechanism by which CPTII deficiency may contribute to neuropsychological disorders such as schizophrenia. We hypothesize that CPTII deficiency leads to abnormal brain development and affects the dopaminergic pathways thought to be dysfunctional in schizophrenia. Using a zebrafish model system to study the effect of CPTII deficiency on brain development and behavior, we knocked down CPTII expression in wildtype (WT) TuAB zebrafish during early development. Knockdown of CPTII was performed by microinjecting translation blocking (TB) and splice blocking (SB) morpholino constructs into single-cell stage zebrafish embryos. Scrambled morpholino-injected and uninjected TuAB zebrafish were used as controls. At 5 days post fertilization and injection, zebrafish were analyzed by light microscopy and a significant number had cardiac edema, curved tails, decreased body length, and abnormal eye and brain development. Average standard length of TB and SB morpholino injected fish significantly decreased by 128.2± 17.9µm and 316.7± 48.2µm as compared to controls ($p<0.0001$, ±=SEM). Distance to the rump in TB and SB morpholino injected fish significantly decreased by 168.5± 24.6µm and 534.5± 80.1µm as compared to controls ($p<0.0001$, ±=SEM). The distance between the eyes indirectly measures telencephalic brain development. The distance between the eyes in SB morpholino injected fish significantly decreased by 48.5±8.4µm compared to controls ($p<0.001$, ±=SEM). Whole mount staining was performed using Alcian blue and Oil red O stains. Deformed Meckel's cartilage, ceratohyal cartilage, and ceratobranchials cartilage was revealed in Alcian blue stained knockdown fish as compared to controls. Decreased lipid deposition was present in knockdown larvae stained with Oil Red O. LC-MS/MS analysis of total acylcarnitine levels was performed and showed significantly increased levels of total acylcarnitines in TB and SB compared to controls ($p<0.001$, $p<0.01$, ±=SEM). Recent electrophysiological studies have been performed using the microelectrode system MED64 to investigate neural network function and seizure susceptibility, since seizures have been reported in some patients with CPTII deficiency. We continue to analyze these data. Taken together, our work shows an important role for CPTII in nervous system development and function. Continued work will demonstrate whether these deficiencies are specific to neurotransmitter pathways that may underlie neuropsychological disorders.

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DETERMINING THE INFLAMATORY IMPACT OF LONG NON-CODING RNA EXPRESSION IN OTOTOXICITY USING AN AUDITORY CELL LINE

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Aminoglycoside antibiotics are a subset of antibiotics frequently prescribed in clinical practice because of their effectiveness and relative low cost when treating severe infection. Ototoxicity and permanent hearing loss are recorded in 20-50% of patients with bacterial infections following treatment with aminoglycosides. This damage is exacerbated by infection-induced inflammatory responses in the cochlea. To develop novel treatments for the alleviation or inhibition of these inflammatory responses associated with ototoxicity, we must better understand the molecular mechanisms behind pro-inflammatory pathways in the inner ear. Preliminary data shows that inflammatory responses in both animal models and in auditory cell lines involve regulation of gene expression by long noncoding RNA (lncRNAs). **We hypothesize that differentially expressed lncRNAs, like lincRNA-Cox2, may play a role in proinflammatory responses and that blocking these responses will reduce inflammation and ototoxicity seen with aminoglycoside treatment.** My *in vitro* data demonstrate that differential expression of lncRNAs in House Ear Institute of Corti 1 (HEI-OC1) auditory cells occurs following exposure to bacterial lipopolysaccharide (LPS). HEI-OC1 cells were unstimulated or stimulated with different concentrations of LPS, a portion of the gram-negative bacterial cell wall. Data suggest that at least lincRNA-Cox2 is significantly overexpressed when auditory cells respond to LPS as compared to controls.. A more robust understanding of the mechanisms of inflammation in the cochlea and the mechanisms of ototoxicity could identify therapeutic targets for the treatment or prevention of hair cell death and hearing loss following antibiotic delivery for ear infections. Given the number of children treated globally with aminoglycosides each year, there is a clear and present need to understand the mechanisms of aminoglycoside-induced ototoxicity.

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DEVELOPING 3D HYDROGEL SCAFFOLD AND SCAFFOLD LESS SYSTEMS THAT ENABLE HUMAN MESECNHYMAL STEM CELL GROWTH AND TRANSFECTION

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Gene therapy is a field that focuses on the modification of genetic material via the administration of exogenous nucleic acids to host cells and is one of many therapies for various diseases. Gene delivery happens through the process of transfection in which a lipid forms a structure with a nucleic acid and is engulfed in the cell through endocytosis. Adipose-derived human mesenchymal stem cells (hMSCs) make good delivery vehicles due to their immunomodulatory properties and the ability of gene delivery to improve their therapeutic properties. While most studies culture cells in a two-dimensional (2D) environment for simplicity purposes, unrealistic proliferation rates, poor cell differentiation, and limited cell-cell communication are all indicators that conditions in a 2D system cannot accurately simulate *in vivo* surroundings. Therefore, this project aims to investigate the growth and transfection efficiency of hMSCs in three-dimensional (3D) environments using both hydrogel scaffolds and scaffold less matrices that rely on the self-assembly of cells into spheroids. We transfected hMSCs with the eGFP-Luciferase plasmid prior to their spontaneous self-assembly and suspended the cells in cell culture media for twenty-four hours before looking at the expressed fluorescent eGFP protein. We demonstrated that delivery of the eGFP-Luciferase plasmid of hMSCs in cell aggregates show a lower protein content and bioluminescence in contrast to their 2D counterpart twenty-four hours after seeding. Future experiments pertaining to this project would aim to increase transfection efficiency through priming of the cells with glucocorticoids and developing efficient methods to transfect encapsulated hMSCS into alginate-hydrogel scaffolds.

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 by inhalation three times during a 3-day period (days 0,1,2). Single cell suspensions were stained with 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+ (cDC1s) and CD103- (cDC2s), two DCs that have been implicated in capturing PN to mount PN-specific responses. Interestingly, both cDC1s and cDC2s were reduced in male mice exposed to PN when compared to their female PN-exposed counterparts. These results strongly suggest that testosterone modulates immune responses against PN exposure. Future studies will build on this fascinating data to allow us to better understand sex differences associated with PN allergy.

THE MOLECULAR MECHANISM OF EARLY SYNAPTIC LOSS IN ALZHEIMER'S DISEASE

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Alzheimer's disease (AD) is the most prevalent cause of senile dementia, and there is no disease-based treatments currently available. It is a neurodegenerative illness characterized by degenerative abnormalities in a number of neurotransmitter systems as well as changes in homeostasis. Neurons are continuously in contact with other brain cells. When a neuron gets a signal from another neuron, it creates an electrical charge that travels down its axon and releases neurotransmitter molecules across a gap known as a synapse. Notably, synaptic loss is one of the significant and critical hallmarks of AD. Interestingly, during the early stage of AD, it was recently observed that synaptic loss already happened. Focusing on the early-stage of AD can potentially provide better prevention and treatment of AD. *Approach*: Recent study has shown that the proline-rich tyrosine kinase Pyk2 is necessary and sufficient for regulating the elimination of inactive synapses. Also, differential expression in the Pyk2 locus increases the chance of developing late-onset AD, and in hippocampal slices, Pyk2 deletion samples are protected from amyloid-β-oligomer (Aβo)-induced suppression of long term potential (LTP). Importantly, hippocampal slices treated with Aβo showed a decrease in extracellular field excitatory postsynaptic potentials (fEPSPs). However, the pathophysiological role of Pyk2 and the mechanism in which Pyk2 regulates synaptic loss is not well-understood. Specifically, studies suggested that the microglia, macrophages that prune extra synapses during development, are improperly activated and cause synapse loss in AD. Additionally, in cardiomyocytes, Pyk2 has the ability to directly phosphorylate mitochondrial calcium uniporter (MCU), which increases mitochondrial Ca2+ uptake. The MCU, which is found on the mitochondrial inner membrane, is the main channel responsible for mitochondrial Ca2+ influx. In the case of AD, studies suggested that mitochondrial dysfunction is one of its early pathomechanisms. Changes in mitochondria morphology is linked to increased amyloid-beta (Aß) production. However, whether mitochondrial dysfunction affects synaptic loss in AD is unclear. Here, we will test the hypothesis that in the presynaptic bulb, Pyk2 drives synaptic loss in AD via microglia mediation and/or mitochondria Ca2+ buffering. I propose to study mechanisms of early synaptic loss in Alzheimer's disease using a cell biology approach and fiber photometry to yield new insight regarding this important problem.

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DIABETIC TRIPLE NEGATIVE BREAST CANCER: POLYAMINE ENZYMES, ORNITHINE DECARBOXYLASE AND SPERMINE OXIDASE AS POTENTIAL TARGETS

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Breast cancer (BC) is the second leading cause of death in women. Co-existence of diabetes and BC, termed diabetic BC, can be lethal, leading to higher mortality (15-40%) than BC alone. In triple negative breast cancer (TNBC) patients, the chance of TNBC recurrence is about 3 months, and the chance of mortality can be as high as 75%. TNBC is highly refractive, heterogenous, and resistant to most chemotherapies. Polyamines, which are ubiquitous in most cells, and play a role in cell growth, have been shown to be elevated in cancer, though their role in diabetic BC has not been explored. We hypothesized that high glucose/diabetic conditions increase TNBC cell proliferation through modification of the enzymes (ornithine decarboxylase and spermine oxidase) in the polyamine pathway. The objective was to determine potential targets in the polyamine pathway to mitigate TNBC advancement in diabetic conditions. For this purpose, MDA-MB-231 (TNBC) and MCF10-A (normal breast epithelial) cell lines were used. Both were treated with low (5mM) and high glucose (25mM) concentrations and effects on polyamine levels, polyamine enzyme, and cell proliferation were monitored. Polyamine levels were assayed using reverse phase high performance liquid chromatography. Cell proliferation was assessed using a fluorescence-based assay, and polyamine enzyme expression was monitored at the mRNA and protein level using RT-PCR and Western Blots. Samples were sent to Johns Hopkins University for polyamine enzyme activity analysis. Further, an approved inhibitor of polyamine synthesis, alpha-difluoromethylornithine (α-DFMO, 5mM) was used in combination with glucose treatments. Under diabetic/high glucose conditions, putrescine levels were elevated in MDA-MB-231 cells (135%), which correlated with higher cell proliferation (123%). Polyamine enzyme activity of ODC increased (from ~75 pMolCO2/hr/mg protein to ~150 pMolCO2/hr/mg protein) and SMOX decreased (from ~0.4 pMolH202/min/mg protein to ~0.06 pMolH202/min/mg protein) in concert with changes observed at protein levels with high glucose exposure. DFMO was effective in reducing polyamine levels and cell proliferation, however re-supplementation of polyamines (spermidine and spermine) restored cell proliferation to that, indicating that DFMO is only cytostatic. MCF-10A cells showed marked elevation in cell proliferation with high glucose. DFMO prevented this increase; however, no apparent change was observed in polyamine levels. The polyamine biosynthetic enzymes (ornithine decarboxylase and spermine oxidase) play an active role in increasing cell proliferation under high glucose conditions in TNBC. Since DFMO caused only cytostatic effects, there is a need for a more targeted approach to regulate polyamine levels and mitigate TNBC growth under diabetic conditions.

DETERMINING THE MECHANISM OF ACTION OF AN IMMUNOMODULATING, ANTI-SCHISTOSOMAL COMPOUND SA01

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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 is praziquantel (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 compound 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. To explore this immunological phenotype, transcriptomics is conducted to analyze expression patterns for genes associated with neutrophil activation and granulopoiesis.

BLOCKING ERK MODULATES INTERFERON PRODUCTION IN RAW 264.7 MACROPHAGES

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Body Innate immunity is supported by processes that are triggered by pathogens when pattern associated molecular patterns (PAMPs) are recognized by pattern recognition receptors (PRRs) on cells. One of these PAMPs is double stranded RNA (dsRNA), which is what many viruses consist of. TLR-3 is a PRR on the cells that recognizes dsRNA. When TLR-3 recognizes dsRNA, it sets off a signaling cascade that includes interferon regulatory factor 3 (IRF3), a transcription factor for producing interferon. Interferon functions by preventing replication of viruses within the cell. Interferon is critical in immune function but too much interferon is cytotoxic and can cause further pathology. While the factors in interferon production have long been known, less is known about factors surrounding the amount and duration of interferon production. Our previous studies of IRF3 revealed putative non-canonical target phosphorylation sites for extracellular signal-related kinase (ERK), a mitogen-activated protein kinase (MAPK) known to be activated by virus infection. Thus, we sought to determine the role of ERK in interferon production. Using RAW 264.7 macrophages, we blocked ERK production through chemical inhibitors and RNAi which resulted in increased antiviral gene expression. This increase in antiviral gene expression also resulted in increased interferon production which signaled through the interferon receptors. Further studies are being done using a mouse model for norovirus to determine if the modulating effects of ERK extend to other viruses. These studies provide insight into the mechanisms of innate immune regulation during virus infections.

REARRANGEMENT REACTIONS OF ETHER-CONTAINING 1,3,4-TRISUBSTITUTED-1,2,3-TRIAZOLIUM SALTS

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1,3,4-Trisubstituted-1,2,3-triazolium salts are quaternary ammonium compounds (QACs) that exhibit antibacterial and antifungal activity. The effectiveness of the antimicrobial activity varies depending on substituent identity. It was previously observed that 1,3,4-trisubstituted-1,2,3-triazolium bromide salts with aryl ether groups at the C4 position undergo relatively rapid rearrangement resulting in the scrambling of N1 and N3 benzyl groups. The purpose of this study was to observe the impact that substituent identity and reaction time have on this rearrangement process. Benzyltriazoles with phenoxymethyl, 4-tert-butylphenoxymethyl, methoxymethyl and phenylethyl groups at the C4 position were prepared using azide-alkyne cycloaddition. The exchange of benzyl and 4-t-butylbenzyl groups at the N1 and N3 positions of such triazolium bromide salts was studied by mass spectrometry and NMR spectroscopy. It was determined that rearrangement rates were strongly promoted by the presence of ether functionality at the C4 position and also moderately impacted by both ether and benzyl group substituent identity. Those analogs that could be prepared cleanly were tested for antimicrobial activity using microdilution minimum inhibitor concentration (MIC) assays against Gram-positive bacteria, Gram-negative bacteria, and yeast. Details regarding the rearrangement reactions 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.

EXAMINATION OF SEX-SPECIFIC DIFFERENCES IN TYPE 2 INNATE LYMPHOID CELLS AND ADAPTIVE IMMUNE RESPONSES FOLLOWING PEANUT EXPOSURE

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An understanding of the mechanism in which peanut (PN) initiates immune responses to generate PN allergy is limited. In addition, the impact sex differences have on the development of PN-specific immune responses is unknown. It has been shown that PN, commonly found in household dust, sensitizes mice via inhalation. This study compared male and female mice exposed to PN, via inhalation, in a 3-day mouse model to investigate how sex differences impacted the response of lung type 2 innate lymphoid cells (ILC2s). After 3-day exposure, lungs were collected. Cells were stained with antibodies to identify ILC2s by flow cytometry. Interestingly, ILC2s were sensitive to sex differences with ILC2s in female PN-exposed lungs having a significantly more abundant response than ILC2s in male PN-exposed lungs. Plasmablasts and T follicular helper cells were also examined in the lung draining lymph nodes (dLN) using an 11-day mouse model. These populations were unchanged due to sex differences in the dLN of PN-exposed male mice when compared to their female PN-exposed counterparts at day 11 harvest. This data suggests that while sex hormonal differences between males and females influence ILC2-mediated responses, these differences do not alter the development of PN-specific adaptive immune responses. Overall, this study provides critical insight into how sex differences could play a role in regulating PN-specific immune responses by pinpointing the activity of male sex hormones.

SYNTHESIS, UV-VIS PROPERTIES 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 arene center is varied, and to optimize potency through variation of N-triazolium and aryl substituents. Aryl azide compounds were synthesized with varying n-butyl, and diethyl substituents. These aryl azides were reacted with p-diethynylbenzene, 1,4-diethynylnapthalene, 1,6-diethynylpyrimidine, 1,5-diethynylnapthalene and 2,6-diethynylnapthalene using a base-catalyzed click reaction to form 1,5-disubsituted-1,2,3-triazole analogs. A library of triazolium salts was prepared by the di-substitution of either 1-iodobutane, 1-iodopentane, 1-iodohexane, 1-iodoheptane, 1-iodooctane or benzyl bromide groups at the N3 position of each triazole ring. A total of 31 molecules were made and analyzed for UV-Vis and 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 0.4 μM against Gram-positive bacteria, 0.8 μM against Gram-negative bacteria and 1.6 μM against yeast. MIC potency for gram negative bacteria was enhanced by the presence of 1-iodoheptane on the N3 position. Disubstituted salts with naphthalene connectivity proved to have the highest MIC potency. Details regarding the synthesis, characterization, UV-Vis properties 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.

SCREENING OF NON-PURINE LIGANDS BINDING TO ADENOSINE RECEPTORS A_1, A_{2A}, A_{2B}, AND A_3

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Adenosine receptors (ARs) are G-protein coupled receptors (GPCRs) which have been shown to have therapeutic potential. ARs are made up of four subtypes, A_1, A_{2A}, A_{2B}, and A_3. A_3AR ligands have previously been indicated to lower inflammation, prevent or treat cancer, and produce antihyperalgesic effects in many preclinical pain models, specifically for neuropathy. We have previously published in animal models that ferulic acid dimer, a non-purine compound with the 3-methoxy phenyl moiety, has non-opioid antinociceptive properties through primarily binding to A_3ARs. Current literature suggests that the antinociceptive properties of a natural compound, incarvillateine, which contains the 3-methoxy phenyl moiety, is mediated through ARs, however there is a lack of sufficient evidence of *in vitro* binding of such compounds at ARs. We thus hypothesized that compounds with the 3-methoxy phenyl moiety show binding to ARs, with an affinity in the submicromolar range. For this study, we performed fluorescent competitive binding assays using cells transfected with ARs: Chinese Hamster Ovary (CHO) cells for A_1 and A_3 receptors and Human Embryonic Kidney (HEK) cells for A_{2A} or A_{2B} receptors. The compounds tested included *trans* cinnamic acid analogs and coumarin analogs. The compounds were synthesized using cavitand-mediated photodimerization. Our fluorescent binding protocol employed the separation method, in which the unbound ligand was removed after equilibrium was reached, via PBS wash. The binding assays performed suggested that *trans* 3-methoxy cinnamic acid dimer was the most effective in binding to A_3ARs, while the monomer did not bind as well. There was very little to no binding observed at the other receptors. Other analogs of *trans* cinnamic acid and coumarin did not show binding at any of the ARs so far. In conclusion, *trans* 3-methoxy cinnamic acid dimer binds to G-inhibitory coupled adenosine receptor, A_3. Future studies will investigate structure-activity-relationship of 3-methoxy phenyl dimers to demonstrate why dimerization leads to superior binding compared to similar monomeric compounds.

THE USE OF CANTHARIDIN IN COMBINATION WITH MELPHALAN TO INDUCE APOPTOSIS AND INHIBIT CELLULAR PROLIFERATION OF MULTIPLE MYELOMA CELLS

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Multiple myeloma is a systematic malignant disease of plasma cells. Melphalan is a chemotherapeutic agent used to treat different cancer types, including multiple myeloma, ovarian cancer, and others. Cantharidin, a compound secreted by many species of blister beetles, has been used in traditional Chinese medicine. Cantharidin has been shown to inhibit cellular proliferation and induce apoptosis in various cancer cells. The goal of these experiments was to test if using cantharidin alone as well as in combination with melphalan would induce apoptosis and inhibit cellular proliferation and cell cycle progression in RPMI 8226 multiple myeloma cells. To find the appropriate concentration of cantharidin for subsequent experiments, we performed MTT assays to determine the inhibitory concentrations at both 25 and 50 percent (IC_{25} and IC_{50}, respectively). The average IC_{25} for cantharidin was 2.5 μM and the average IC_{50} was 4.6 μM. Using the IC_{25} values determined for both melphalan and cantharidin, we next analyzed apoptosis and cell cycle kinetics using staining kits and flow cytometric analysis. With the *FITC Annexin V Apoptosis Detection Kit,* we used two stains to determine if the cells were healthy or in early or late stages of apoptosis after 24 hours treatment. In this test, melphalan alone showed that 12 percent of cells were apoptotic and cantharidin showed 24 percent. Cantharidin in combination with melphalan showed greater than additive effects, with 58 percent of cells having undergone apoptosis. With the *BD Pharmingen BrdU Flow Kit,* we determined what phase of the cell cycle the cells were in, by looking at incorporation of BrdU during replication. Cantharidin had little effect on the cell cycle, while melphalan did induce cell cycle arrest. When used alone, a marginal difference was seen, going from approximately 4.0 percent in G2/M phase with vehicle control treatment to 3.5 percent. Cantharidin combined with melphalan inhibited cell cycle progression to a similar extent as melphalan alone, going from 3.5 percent to 0.5 percent. In this experiment, melphalan alone took the percentage from 5.5 to 0.6. Overall, these results show that cantharidin alone and in combination with melphalan causes\ apoptosis in multiple myeloma cells, but only inhibits cellular proliferation when used in combination. Future experiments would benefit from following specific hours requirements closer to what's written in the procedures, as well as aspirating supernatants instead of pipetting.

EXAMINING THE ROLE OF CHLAMYDIA TRACHOMATIS IN ALTERING INTRA-GOLGI TRAFFICKING KINETICS

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Chlamydia trachomatis is an obligate intracellular pathogen which replicates inside a host cell in a bacteria-modified vacuoles called an inclusion. As other obligate intracellular pathogens, *Chlamydia* exploits the host cell trafficking pathways to acquire nutrients and molecules required for its survival. It is known that the inclusion intercepts Golgi-derived exocytic vesicles. However, it is currently unknown if *Chlamydia* modifies intragolgi trafficking kinetics. We hypothesized that *Chlamydia* slows downs trafficking within the Golgi in order to retain secretory cargo longer to sequester nutrients required for its survival inside the host cell. To test this hypothesis, HeLaM cells were seeded at a density of $2x10^3$cells/100⌈L and infected with Chlamydia trachomatis serovar L2 (CT L2) for 24 hours. Both uninfected and infected HeLaM cells were treated with 1⌈M rapamycin or not for different time frames (0-65mins), then fixed in 4% paraformaldehyde, processed for indirect immunofluorescence. Finally, samples were quantified and imaged using the Operetta CLS High-Content Analysis System. We observed slight differences in percent GFP retained in the Golgi between uninfected and CT L2 infected cells at different timepoints post-rapamycin treatment. These results suggests that *Chlamydia* modifies intragolgi trafficking kinetics in its host cell.

Keywords: Chlamydia, Golgi, trafficking.

CELL-FREE BIOSYNTHESIS OF THE LASSO PEPTIDE KLEBSIDIN

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Antibiotic resistance is a serious and growing problem, and the discovery of new antibiotics is critical in the fight against antibiotic-resistant pathogens. One exciting source of new antibiotics is ribosomally synthesized and post-translationally modified peptides (RiPPs). Many RiPPs possess potent antibiotic activity against closely related microbes and engineering the pathways that produce these compounds could be a rich source of new antibiotics. Here we report cell-free biosynthesis conditions for the lasso peptide klebsidin, a RiPP identified from the bacteria *Klebsiella pneumoniae* with antibiotic activity against *K. pneumoniae*. The klebsidin biosynthetic pathway is extremely tolerant of mutations in precursor peptide substrates, but cellular export for some of these peptide variants may be inefficient, leading to inhibition of host cell growth. To decouple lasso peptide biosynthesis and cellular growth, we developed conditions for robust cell-free biosynthesis of klebsidin, optimizing DNA concentration, T7 RNA polymerase concentration, reaction component composition, and reaction time. Using these optimized conditions, we demonstrate production of wild type klebsidin, a single amino acid variant of klebsidin, and chimeras of klebsidin and other lasso peptides, highlighting the potential of cell-free biosynthesis to produce novel lasso peptide products.

CHARACTERIZING THE IMMUNE RESPONSE OF CELLS TREATED WITH NOVEL ANTI-SCHISTOSOMAL COMPOUND

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Schistosomiasis is a condition caused by a parasitic worm infection that is one of the primary neglected tropical diseases. It infects approximately 250 million people every year, and it causes the second largest economic impact from any parasitic disease. There exists a treatment for Schistosomiasis, however, it is ineffective against the juvenile stages of the worm. There has been a novel drug developed that has been illustrated to have efficacy against all stages of worm infection. However, before this drug can be utilized, the method of action must be determined. Preliminary single cell transcriptomic data from our lab suggests that our compound is acting to enhance the immune response of granulocytes. To further characterize the response of our novel compound, we performed a series of assays to quantify how the compound affects the cellular ability to perform phagocytosis, and how this compound affects the transcriptomic state of HL60, an immortalized promyeloid cell line.

SATB1 FORMS HETERODIMERS WITH SATB2 IN A DNA-INDEPENDENT MANNER.

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Chromatin architecture and the proteins that control it play an essential role in gene regulation. DNA is organized on a spectrum from tightly compacted regions called heterochromatin which are primarily composed of silent genes, to loosely arranged structures called euchromatin which mostly contain active genes. Both Satb1 and Satb2 have been implicated in creating and maintaining chromatin architecture. Satb1 is involved in T-cell development and Th1/Th2 differentiation, while Satb2 is critical for RUNX2 expression leading to osteogenesis. Satb1 has been shown to homodimerize in a DNA-independent manner. Given the high degree of homology between Satb1 and Satb2, it has been hypothesized that Satb1 can also heterodimerize with Satb2. Here we show evidence that Satb1/Satb2 heterodimers form in a DNA-independent manner and that the ULD domain of Satb1 is both necessary and sufficient for heterodimer formation.

STRUCTURAL STUDIES OF THE INTERACTION BETWEEN PROTEINS INVOLVED IN GENE SILENCING

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Following replication, the eukaryotic genome must be condensed to fit inside the nucleus of the cell. In this process, DNA is packaged into structures called nucleosomes, which consist of DNA wrapped around proteins called histones. Genes within nucleosomes are either expressed or silenced, depending on how the nucleosomes interact with each other. The process of DNA condensation after replication is called replication-coupled nucleosome assembly. There are two key proteins responsible for this process: proliferating cellular nuclear antigen (PCNA) and chromatin assembly factor-1 (CAF-1). PCNA, a sliding clamp protein, encircles the DNA and recruits CAF-1. CAF-1 deposits histones on the DNA strand to initiate nucleosome formation. The interaction between PCNA and CAF-1 is critical for the gene silencing. However, the mechanism of binding between these two proteins is not known. The goal of these studies is to determine the structure of the PCNA-CAF-1 interaction. We carried out preliminary X-ray crystallography and small angle X-ray scattering (SAXS) experiments with PCNA and CAF-1. Thus far, we have obtained microcrystals of several PCNA-CAF-1 complexes as well as SAXS data of these structures in solution. We are currently optimizing these assays, but initial data suggest these complexes are forming stable structures. Once these studies are complete, we will have a greater understanding of how the PCNA-CAF-1 interaction maintains proper gene silencing.

DEVELOPING A NEW METHOD TO MAKE AN INSERT TO PROTECT DNA

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To properly store and preserve larger DNA molecules for further study, an insert must be made in which the DNA can be protected for a long period of time, but also be extracted without damage to the DNA when needed. To address this problem, sodium alginate and agarose inserts were created using a dynamic range of concentrations. Varying percentages of sodium alginate and agarose in 1M $CaCl_2$ were combined to find the mixture that produced the best insert. The agarose/alginate mixture was placed into an insert mold and left to solidify. Once solidified, inserts were weighed on a glass slide, and transferred into a bath of the Tris and EDTA solution. To keep the inserts localized for recovery after the time trials, a 3D printed elution concentration device was used, and two acrylamide "roadblocks" were polymerized inside. The inserts were then placed into the area between the two "roadblocks" and weighed after set periods of time. Our goal is to create an insert that stays solid when in storage and then dissolves in a specific solution to allow large DNA molecules to migrate through the insert easier.

THE ROLE OF INLB AS A TARGET FOR mRNA *LISTERIA* VACCINE.

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Listeria monocytogenes is a pathogenic Gram-positive bacillus shaped bacteria that causes listeriosis infection. Listeriosis affects about 1,600 people resulting in an average of 260 deaths per year, generally as a result the consumption of contaminated food. A surface protein called Internalin B (inlB) promotes bacterial entry into mammalian cells where the organism escapes the phagosome to flourish in its host cell. While the number of infections would not historically justify large scale vaccination, new mRNA vaccines are cheaper and more versatile in function and it may be suitable to vaccine more at risk populations. This research begins to explore the possible use of the inlB gene as an mRNA vaccine. We have successfully clone the gene, verified a viable open reading frame and transfected inlB mRNA into HEK-293 cells. We are currently examining possible expression of inlB protein within these transfected cells. This publication was made possible by grants from the National Center for Research Resources (5P20RR016469) and the National Institute for General Medical Science (NIGMS) (8P20GM103427), 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.

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 peptides (RiPPs) with many biological activities. Their threaded lariat structure provides resistance to proteases and constrains their conformation, making them attractive as potential inhibitors for enzymes and protein-protein interactions. This structure, however, makes preparation of lasso peptides by traditional peptide synthetic approaches challenging and necessitates the use of naturally occurring lasso peptide biosynthetic pathways to explore new lasso peptide variants. Here, we evaluated the potential for the biosynthetic pathway that produces klebsidin, a lasso peptide from *Klebsiella pneumoniae*, to convert highly diverse precursor 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 assessed 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 nearly 1,000 precursor peptide sequences that are processed into lasso structures, highlighting the tremendous potential of the klebsidin biosynthetic pathway to produce diverse lasso peptides. For twelve variants that showed inhibition of cellular growth, we verified expression of the expected lasso peptide variant and the expected lariat conformation using mass spectrometry. These results highlight the potential of the klebsidin biosynthetic pathway to generate libraries of novel lasso peptides.

MEASURING MITOCHONDRIAL ENERGETICS BY NAD(P)H PHASOR FLIM AND SHG IMAGING TO COMPARE HEALTHY AND CANCEROUS CELLS

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The current standard method for diagnosing skin cancer uses a punch biopsy, which is invasive and usually only done once there is an observable skin abnormality on the surface. However, skin cancer develops and progresses before a visible mark can be seen. With approximately 700,000 new cases of squamous cell carcinoma (SCC) diagnosed each year, early detection and diagnosis are crucial for treatment effectiveness. In our lab, we've used in vivo phasor fluorescence lifetime imaging microscopy (FLIM) and second harmonic generation (SHG) imaging to monitor energy metabolism and collagen structure. NAD(P)H and flavoprotein are used as fluorescent indicators of metabolic activity. Our goal is to see if NAD(P)H phasor-FLIM and SHG imaging are dependable methods for a non-invasive biopsy. To test this technique, we completed a year-long study comparing chronic UVA-exposed SKH1 mice with sham SKH1 mice. Throughout the study, we imaged the skin of each mouse with NAD(P)H phasor-FLIM. Regions of interest were identified in each image and NAD(P)H bound fraction and collagen structure were measured using phasor analysis. Our data demonstrated that UVA-treated SKH1 mice exhibited a lower NAD(P)H bound fraction and that changes in NAD(P)H bound fraction emerged around the same time that papillomas developed on the mice. Ultimately, our data demonstrates that our imaging techniques can distinguish between cancerous and healthy tissue in vivo.

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SUPRAMOLECULAR PHOTOCYCLOADDITION CHEMISTRY: STEREO- AND REGIOSELECTIVE SYNTHESIS CINNAMIC ACID DIMERS AND THEIR BIOLOGICAL STUDY

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Photocycloaddition (PCA) of alkenes is a reaction with fundamental chemistry significance and applied potential. PCA is important in many ways including in industry, such as photolithography, optical storage, photopolymerization; products of PCA contain the cyclobutene moiety, which are essential structural cores of biomolecules and natural compounds. Mechanistic knowledge of its excited state dynamics and ground-state preambles are crucial to a chemist's ability to utilize this reaction. Our lab specializes in achieving efficient and stereoselective PCA of alkenes by using the cavitand-mediation strategy, which takes advantage of proximal positioning of two photoactive reactants within a macrocyclic cavitand. Our past works have provided several supramolecular and photochemical insights into the cavitand-mediated PCA, which was used to synthesize more than fifty novel dimeric compounds. We are now dedicating our efforts towards understanding the reaction dynamics in order to maximize reaction yields by manipulating previously unexplored aspects of the reaction such as overall concentration, temperature, sensitization, and wavelength. We present our findings on the influence of concentration changes and temperature on the product selectivity and yields. Due to their close resemblance to truxillic- and truxinic acid-based natural compounds, products of these reactions were also tested for their anti-cancer properties and found to possess anti-neoplastic properties at sub-millimolar concentrations in some cases.

INVESTIGATING ENZYMATIC RESISTANCE TO FOSFOMYCIN BY FOSB IN GRAM-POSITIVE BACTERIA

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Fosfomycin, a broad spectrum antibiotic, is used clinically to treat lower urinary tract infections and gastrointestinal infections and has been suggested for treatment of multi-drug resistant bacterial infections. However, fosfomycin resistance enzymes limit the efficacy of the antibiotic in the clinical setting. A better understanding of the enzymatic mechanism of fosfomycin resistance and fosfomycin inhibition could be used to increase the efficacy and use of fosfomycin. One resistance enzyme, FosB, is a M^{2+}-dependent thiol-transferase found in Gram-positive bacteria and modifies fosfomycin by catalyzing nucleophilic addition of a thiol to fosfomycin resulting in an inactive compound. *In vitro* time course kinetic analyses for FosB from four different bacterial strains using L-cysteine and bacillithiol (BSH) reveal a preference for BSH over L-cysteine. A probe of the metal dependent activation of FosB by Ni^{2+}, Mg^{2+}, Zn^{2+}, and Mn^{2+} indicates the highest activation of FosB is observed with Mn^{2+} as the metal cofactor, whereas Zn^{2+} inhibits the FosB enzymes. Thus, FosB is a Mn^{2+}-dependent BSH transferase. Several high-resolution crystal structures of FosB have been determined. They reveal a BSH binding pocket and suggest a highly conserved loop region must change conformation to bind fosfomycin. GlcNAc-mal is a precursor molecule in the biosynthetic pathway for BSH. GlcNAc-mal is structurally similar to BSH, but it lacks the thiol group necessary for efficient FosB activity. Preliminary results indicate that GlcNAc-mal may be an *in vitro* inhibitor for FosB, which is expected to occur due to competition for binding to the BSH binding pocket. Additional *in vitro* kinetic analysis and *in vivo* inhibitor analysis is currently underway. If GlcNAc-mal proves to be an efficient inhibitor of FosB, it could be used as a starting point for drug development to improve the efficacy of fosfomycin in the clinical setting.

IMPACT OF LOCAL TEMPERATURE APPLICATION ON SKELETAL MUSCLE MARKERS OF PROTEOLYSIS AND MYOGENESIS

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Many popular temperature-associated post-exercise muscle recovery methods are promoted as beneficial to recovery and performance despite the absence of evidence-based recommendations. However, before investigating the influence of temperature on post-exercise recovery, the exercise stimulus must be removed, and the independent effects of temperature examined. **Purpose:** To determine the impact of local hot and cold thermal wrap application on skeletal muscle markers of breakdown (proteolysis) and growth (myogenesis) at rest. **Methods**: Thermal wraps were applied to the *vastus lateralis* (*VL*) of 24 (19 males, 5 females) healthy subjects (age 26.5±6.5yrs, height 1.77±10.6m, weight 83.2±15.8kg, and BF% 18.7±7.4%) while resting for 4h. One randomized limb received local temperature application of either 40°C (HOT) or 10°C (COLD) via water-filled thermal wraps, with the contralateral limb receiving no treatment (RT, n=24). A one-way ANOVA compared HOT (n=12), RT (n=24), and COLD (n=12) skin temperatures, intramuscular temperatures, blood flow, and gene expression associated with proteolysis and myogenesis via muscle biopsy. **Results:** Skin and intramuscular temperatures were higher in HOT (+2.5°C, $p<0.001$; +0.9°C, $p<0.001$) and lower in COLD than RT (-21.6°C, $p<0.001$; -14.8°C, $p<0.001$; respectively). Blood flow measurements by arterial ultrasound were not different (velocity, $p=0.263$; flow, $p=0.184$; shear, $p=0.450$). Proteolytic gene expression was higher in COLD (*FBXO32*, $p=0.021$ vs. RT; *FOXO3a*, $p<0.001$ vs. RT and vs. HOT; *TRIM63*, $p<0.001$ vs. RT and vs. HOT). Myogenic gene expression was lower in COLD (*MYO-G*, $p<0.001$ vs. RT and vs. HOT*;* *MYO-D*, $p<0.001$ vs. RT and vs. HOT). Also, the myogenic-related gene, *MYF6* was higher in COLD ($p<0.001$ vs. RT and vs. HOT). Local HOT application did not induce any differences (vs. RT) in gene expression for markers of proteolysis ($p<0.05$) or myogenesis ($p<0.05$). Temperature had no influence over the phosphorylation rate (phosphorylated/total protein) of myogenic proteins (mTOR, p70S6K1, and 4EBP1) compared to RT conditions ($p<0.05$). **Conclusions:** This local cold application intervention enhanced several genes associated with the breakdown (proteolytic) and inhibited several genes associated with the growth (myogenic) of skeletal muscle. These data bring into question *popular* cold-associated post-exercise recovery methods which may limit the transcriptional response associated with muscle development. *Supported by NE-INBRE, NIGMS Funding (P20GM103427).*

PHYSIOLOGICAL SIGNIFICANCE OF SUPEROXIDE DISMUTASE IN *S. AUREUS*

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Reactive oxygen species like superoxide ($O_2^{\cdot-}$), hydrogen peroxide (H_2O_2) and hydroxyl radicals ($OH^{\cdot}$) are adventitious byproducts of aerobic metabolism that readily damage cellular macromolecules. The human pathogen *Staphylococcus aureus* expresses two superoxide dismutase (SOD) enzymes, SodA and SodM, that can reduce $O_2^{\cdot-}$ mediated oxidative stress. Although both SODs have been shown to play important role in countering host-derived $O_2^{\cdot-}$, their role in protection from endogenously produced $O_2^{\cdot-}$ has not yet been elucidated. Here, we reveal that both SodA and SodM are important for the optimal growth of *S. aureus* under aerobic conditions. The *sodAsodM* double mutant produced higher levels of $O_2^{\cdot-}$ and exhibited a decreased growth yield relative to the parental strain. The enhanced sensitivity of the *sodAsodM* mutant to endogenously produced $O_2^{\cdot-}$ was effectively reduced upon anaerobic growth. The deleterious effects of $O_2^{\cdot-}$ on growth yield of the *sodAsodM* mutant resulted from decreased activity of multiple enzymes of the TCA cycle. Finally, we provide evidence that supports a regulatory, rather than a direct effect of $O_2^{\cdot-}$ in reducing activity of TCA cycle enzymes in the *sodAsodM* mutant. Collectively, our study highlights a physiological role for staphylococcal SODs in promoting metabolic activation of the TCA cycle during growth.

FLUORESCENCE GUIDED MORPHOMETRY IN CHEMO-RADIOTHERAPY AGAINST BRAIN CANCERS

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Glioblastoma is the most common form of brain cancer affecting over 12,000 people per year in the United States. It is commonly treated with a combination of chemotherapy and radiotherapy but has one of the worst treatment outcomes: a median survival of 12-15 months. In this project, we use a standard clinical combination of Temozolomide and radiation on two glioblastoma cell lines: T98G and U87. To improve therapeutic outcome, we subject the cells to several novel nanoparticles such as graphene quantum dots, serving as radiosensitizers, before chemo-radiotherapy. The chemo-radiotherapy targets and disrupts the structure of DNA in order to harm rapidly dividing cells of the tumor. Fluorescent imaging after exposure to these conditions enables us to detect, evaluate, and quantify morphometric changes in cancer cells. We use the dye Hoechst to stain the nucleic acids, highlighting the DNA material in the nucleus and the dye, Calcein, to stain the cytoplasm, which allows for a comparison between nucleus and cytoplasm. Using morphometric parameters such as lacunarity, circularity, mitotic cell count, and nuclear-to-cytoplasm ratio, we have quantified the damage caused by cell exposure to chemotherapy and radiation. Our results consolidate the clonogenic assays also being done in our lab, enabling further development and refinement of nanoparticle-mediated chemoradiotherapy against brain cancers.
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SECONDARY AND TERTIARY STRUCTURE OF GENOMIC RNA FROM NEURTROPIC ENTEROVIRUSES

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Enterovirus-D68 (EV-D68) is a positive-sense single-stranded RNA virus within the family *Picornaviridae*. Prior to 2014, EV-D68 was thought to cause only respiratory illness, primarily in children. However, in 2014 an EV-D68 outbreak occurred in the United States and Canada. In addition to the expected increase in respiratory illness cases, there was an increase in cases of acute flaccid myelitis (AFM) associated with EV-D68 infection. Research into EV-D68 has revealed that pre and post 2014 outbreak strains can infect neurons in cell culture. Suggesting that rather than neurotropism being gained by the 2014 outbreak strains, the neurovirulence of these strains was increased. Sequencing of 2014 outbreak isolates revealed variations in the 5' untranslated region (5' UTR) of the genome, in a location known to serve as an Internal Ribosomal Entry Site (IRES), as well as a 25 to 34 nucleotide deletion in a location called the spacer region, when compared to the Fermon strain. The 5' UTR has been shown to be an important contributor to neurovirulence in other enteroviruses, such as poliovirus and Enterovirus-A71 (EV-A71). Therefore, mutations in the 5' UTR found in the 2014 strains could contribute to the increased neurovirulence observed during the outbreaks. We have analyzed genomic RNA structure in two strains of EV-D68, the Fermon strain and KT347251.2, isolated in 1962 and during the 2014 outbreak respectively. The 5' UTR of both strains were cloned into the p2RZ hammerhead ribozyme plasmid, a plasmid designed to produce RNA molecules. RNA was transcribed from each plasmid and folded into the native conformation. The secondary structure of the RNA was determined using a sensitive chemical modification approach called SHAPE-MaP and TurboFold II. The tertiary structure of the EV-D68 RNA molecules were determined using 3dRNAscore. Comparison of the secondary and tertiary structural features of EV-D68 pre and post outbreak can reveal structural changes that contribute to neurovirulence and neuroinvasion. Comparison of neurotropic enterovirus genomic RNA structures can be expanded to viruses other than EV-D68, such as EV-A71 and Coxsackievirus B3. EV-A71 is a positive-sense single-stranded RNA virus that can cause AFM. Secondary and tertiary structures of EV-A71, strain KF312457.1, were generated using the same methods as the EV-D68 isolates. Comparison of the 5' UTR of these neurotropic strains could reveal conserved RNA structures that contribute to neurotropism across all enteroviruses which can be targeted by therapeutics to prevent neurological effect in those suffering from enterovirus infections.

THERMOREGULATION WITH CHEMICAL ACTIVATION OF TRPV1 RECEPTORS

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BACKGROUND: Topical capsaicin receptors can invoke a tingling sensation that can be perceived as "heat". The capsaicin receptor is a part of a family of membrane proteins called transient receptor potential (TRP) channels. Capsaicin activated TRPV1 receptors lead to vasodilation of the skin. This vasodilation is vital to the cooling of the body, as it gets rid of excess heat, aiding in thermoregulation. It is currently unknown if over-the-counter capsaicin cream can impact whole body performance or thermoregulation . **PURPOSE:** To determine the impact of topical capsaicin on thermoregulation and its perception during exercise while in a hot environment. **METHODS:** 12 subjects will apply 0.1% capsaicin cream or placebo cream (randomized order), using a gloved hand, to their distal limbs. Core temperature, skin temperature, heart rate, skin blood flow and sweat rate will be continually measured to gauge effects on thermoregulation. Participants will also be asked to report their thermal sensation according to the standardized ASHRAE thermal sensation and comfort scales.
IMPLICATIONS: This study will provide evidence needed for the development of novel interventions that may aid in the treatment or prevention of heat related illness.

CELL MORPHOMETRY FOR ADVANCING NANOPARTILCE-MEDIATED RADIOTHERAPY AGAINST GLIOBLASTOMA

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Glioblastoma Multiforme (GBM) is the most common and most aggressive form of brain cancer. There is currently no cure for GBM. Treatment is largely palliative and usually includes surgery followed by radiation therapy and/or chemotherapy. Hence, there is intensive research for new therapies. Nanoparticle-mediated therapy (NPRT) is an emerging option. The goal of this research is to advance NPRT for GBM using fluorescence guided cell morphometry. Clinically relevant doses were delivered to two GBM cell lines (T98G and U87), along with several nanoparticles including carbon quantum dots, graphene quantum dots and CdSe(ZnS) quantum dots. Real time cell migration measurements were done using an electric cell impedance sensing device (ECIS). Clonogenic assays were performed using CytoSMART Omni, a cloud-based real-time cell imaging device. Fluorescence images were taken using both Hoechst and Calcein dyes. These fluorescent dyes stain nucleic acid and cytoplasm, respectively. Morphometric analysis was done using the ImageJ software and parameters such circularity, nuclear to cytoplasm ration, mitotic cell count, were extracted. The mitotic cell ratios between all conditions provided the most distinguishing criterion and holds promise as an early read-out of possible treatment outcomes. Preliminary results suggest that the use of carbon quantum dots in conjunction with radiotherapy significantly decreases the mitotic cell ratio within 24 hours of treatment. This trend also fits with the 14-day and 21-day survival fractions from clonogenic assays. Fluorescence imaging enabled very early detection of parameters possibly predictive of treatment outcomes for various nanoparticles tested for their ability to enhance radiotherapy against glioblastoma cells. These findings may facilitate the development of effective NPRT against brain tumors.

IMMUNE CELL METABOLISM MODELING

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Computational Biology is a building field of biology that is modernizing many of the medical research methods we are familiar with. This field is especially powerful not because of the financial ease or time convenience, but because of the ability computers possess to understand and model complex situations in the human body. With all the components of the immune system in the human body, there is a great opportunity that is available from Bioinformatics. Immune cell metabolism is an especially important field as of late, given the pandemic. With the growth and transformations of COVID-19, being able to model the effects on the body of a new disease or stimulus became a necessity. By using the data from hundreds of experiments done in the past, we can create a reprogrammable model of immune cell metabolism. This potential tool would allow doctors and scientists alike to estimate the effects of any stimulus and understand the diseases all the better. Cellular metabolism modeling is a very effective and powerful process that can modernize much of the research many scientists do.

VALIDATION OF SMALL-MOLECULE, NON-NUCLEOSIDE INHIBITORS TARGETING VIRAL RNA-DEPENDENT RNA POLYMERASE IN FLAVIVIRIDAE.

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Flaviviridae comprise an important family of single-stranded, positive-sense RNA arboviruses classified as major human pathogens[1]. Flaviviruses include Dengue virus (DENV), Zika virus (ZIKV), Yellow Fever virus (YFV), West Nile virus (WNV), and Japanese encephalitis virus (JEV). Flavivirus epidemics are globally distributed, infecting up to 400 million people annually and posing serious public health challenges[2]. Severe Flavivirus neurotropic infection is characterized by neurological disease, pyrexia, teratogenic effects, hemorrhagic fever, acute flaccid paralysis, hepatitis, and vascular shock syndrome[1,2]. DENV is the leading cause of arthropod-borne viral disease worldwide, infecting more than 100 million humans annually[3]. Severe, untreated Dengue fever is characterized by fatality rates exceeding 20%, killing 20,000-25,000 people annually[3]. Acute symptoms of ZIKV infection include arthralgia, maculopapular rash, and conjunctivitis, while chronic symptoms include fetal microcephaly and severe neurological disorders in adults, such as Guillain-Barré syndrome[4]. Currently, there are no FDA-approved therapeutics for Flavivirus infection, constituting a serious burden on global public health systems. The goal of this work is to identify and validate non-nucleoside, small-molecule drugs to treat flaviviridae infection. The Flavivirus genome encodes 3 structural proteins and 7 non-structural proteins, including Non-structural Protein 5 (NS5)[5]. NS5 is a large, highly conserved flavivirus enzyme composed of an N-terminus methyltransferase and C-terminus RNA-dependent RNA polymerase (RdRp)[5]. RdRp contains a triple aspartic acid motif conserved across flaviviridae which is essential for RNA replication and stabilizing RNA template binding via electrostatic attractions at the RdRp active site[6]. Hence, RdRp is an attractive target for anti-flavivirus drug development. We hypothesize that small-molecule, non-nucleoside inhibitors can bar viral RNA replication, thus inhibiting flavivirus infection, via competitively inhibiting the active site of RdRp. *In silico* compound screening will be conducted against the active site of RdRp to identify putative compounds with RdRp binding and inhibitory capabilities. Top-hit compounds will be purchased and screened against Zika viral strain MR-766 and Dengue Serotype 2 with Vero-E6 cells. Screening, IC_{50}, and CC_{50} analysis will be carried out via Infection, Plaque, and MTT viability assays to identify compounds with low cytotoxicity and high viral inhibition capabilities, with the goal of identifying and validating compounds which limit flavivirus infection.

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MATCHA & MELPHALAN FOR MULTIPLE MYELOMA: THE EFFECTS OF COMBINING GREEN TEA-DERIVED EGCG WITH MELPHALAN ON HUMAN MULTIPLE MYELOMA CELLS

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Multiple myeloma (MM) is the second most common form of blood cancer in the United States. Fortunately, the survival rate for people with MM has improved throughout the years due to the development of novel cancer therapies such as targeted drug therapy. One common chemotherapy drug used to treat MM is melphalan (L-phenylalanine mustard; L-PAM). At high doses, it has shown considerable efficacy—but at the cost of high toxicity and unpleasant side effects. Thus, it may be beneficial to combine natural anti-cancer agents with melphalan to decrease toxicity. A phytochemical that has been well-documented in scientific literature as a potent antiproliferative agent on human cancer cells is (-)-epigallocatechin-3-gallate (EGCG), a powerful antioxidant found in green tea. Using the MM cell line RPMI 8226, we investigated the effects of EGCG combined with L-PAM on MM cell proliferation and viability, apoptosis, and the cell cycle during a 24-hour period. This was done to evaluate the potential of using EGCG as an additional component in MM therapy to hopefully lower the dose and toxicity of L-PAM. Using the cell proliferation assays, IC_{25} and IC_{50} values were determined for L-PAM. Treating with EGCG alone showed no cell death with the doses used. In apoptosis assays, samples treated with L-PAM alone and EGCG alone exhibited apoptosis rates above control levels. Combining EGCG and L-PAM, however, resulted in consistently less than additive effects in four separate experiments. Cell cycle analyses revealed that EGCG did not show any inhibitive effects on the cell cycle by itself. Furthermore, when combining the two drugs, EGCG did not alter the cell cycle inhibition induced by L-PAM. Overall, the results of these studies did not confirm any additive antiproliferative or apoptotic effects induced by combining EGCG with L-PAM on MM RPMI 8226 cells *in vitro*. Further studies are needed, such as utilizing a longer incubation period (e.g., at 48 and 72 hours) and determining why the combination appears less than additive in this cell line. *This publication was made possible by grants from the National Center for Research Resources (5P20RR016469) and the National Institute for General Medical Science (NIGMS) (8P20GM103427), 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 THE EFFECTS OF MELPHALAN IN COMBINATION WITH PUNICALAGIN ON RPMI 8226 MULTIPLE MYELOMA CELLS

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Multiple Myeloma (MM) is a malignant disease of the blood in which there is uncontrolled proliferation of plasma cells, hindering the body's ability to fight infection. Treatment for MM may include high doses of melphalan (L-phenylalanine mustard; L-PAM), a chemotherapeutic agent which can be toxic. Punicalagin (Pug), an extract found in pomegranates, has been used as medicine since ancient times because of its antioxidant and anti-inflammatory properties. This extract inhibits matrix metalloproteinases, causing apoptosis in MM cells. Combining Pug's apoptotic effects with L-PAM may allow clinicians to keep drug doses low while increasing desired anti-cancer effects. Using RPMI 8226 MM cells, we studied the effects of L-PAM and Pug separately and in combination, on proliferation, apoptosis, and the cell cycle. MTT analysis was used to obtain IC_{25} values. L-PAM IC_{25} was 45 μM. Pug MTTs were inconclusive, so we used the highest dose from the MTT, 150 μg/ml. Using a flow cytometer, apoptosis was analyzed after 24 hours. Results showed 31% cell death with L-PAM vehicle control (VC) and Pug VC combined, 54% apoptosis with L-PAM only, and 57% with Pug only. When L-PAM and Pug were combined, a total of 73% of cells were apoptotic, showing slightly less than additive results. Thus, there is a positive effect of combining these drugs. This experiment was repeated and showed similar results but must be repeated again. A BrdU Flow Kit was used to examine the cell cycle. L-PAM alone arrested myeloma cells, as has been described in literature: 25% of cells treated with VC were in the G2/M phase, as opposed to 13% of those treated with L-PAM. Conversely, Pug showed an increase in cells in G2/M: 29.5% in G2/M after Pug treatment, compared to 17% for the VC-treated cells. Pug was able to partially overcome the L-PAM-induced cell cycle inhibition, with 14% of cells in the G2/M phase after combination treatment. Analyzing data through a larger time frame, 48-72 hours, may provide more information on the effectiveness of Pug. Results from this study are promising and should be further studied for treatment of MM. *This publication was made possible by grants from the National Center for Research Resources (5P20RR016469) and the National Institute for General Medical Science (NIGMS) (8P20GM103427), 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.*

CAVITAND-MEDIATED CROSS-PHOTOCYCLOADDITION OF ARYLALKENES

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The cavitand-mediated photocycloaddition (PCA) of arylalkenes has been established by us as a reliable method of producing tetra-substituted cyclobutanes. The product stereo- and regioselectivity is governed by supramolecular interactions of the reactants. Having pioneered this chemistry over the last decade, we are currently expanding the scope of this approach due to direct cross PCA between two photoactive arylalkenes. While PCA is a very well-suited and utilized chemistry, very few examples exist in photochemistry literature of the crossed reaction. We present our findings on our effort to understand and tame this reaction to generate novel asymmetric cyclobutane structures. Owing to the similarity of the products to natural pharmacophores truxillic and truxinic acid, the products generated from these reactions have been explored for anti-cancer properties as well.

FATE MAPPING REVEALS HETEROGENEITY IN COCHLEAR MACROPHAGES IN STEADY-STATE AND AFTER ACOUSTIC TRAUMA

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Macrophages reside in a normal mammalian cochlea. After noise-induced hearing loss and cochlear damage, there is infiltration of circulating monocytes from vasculature that may differentiate into macrophages. Studies out of the Kaur lab demonstrate that macrophages aid in the protection/repair of spiral ganglion neurons (SGNs) following noise trauma. This neuroprotective role of macrophages is mediated through the fractalkine signaling axis (CX_3CL1-CX_3CR1). Since both resident and recruited macrophages express the fractalkine receptor (CX_3CR1) it remains unknown whether resident and recruited macrophages are functionally distinct in their promotion of SGN protection/repair. Therefore, it is critical to differentially examine resident and recruited macrophages in order to apply macrophage mediated repair and protection of SGNs in a clinical setting. We used a robust fate mapping model to label CX_3CR1 expressing resident and recruited macrophages distinctly to determine the ontology, spatial distribution, fate, and phenotype of resident and recruited macrophages in noise injured cochlea. We crossed Tamoxifen inducible $CX_3CR1^{YFP-CreER/YFP-CreER}$ mouse line with Rosa-lsl-tdTomato($R26^{RFP}$) reporter mouse line. The progeny $CX_3CR1^{YFP-CreER/wt}$:$R26^{RFP}$ were injected with tamoxifen or vehicle at 4 weeks of age and euthanized at various time points post-injection to determine Cre recombination efficiency in CX_3CR1 lineage in blood and cochlea and to determine the turnover rate of cochlear resident macrophages. Tamoxifen-injected $CX_3CR1^{YFP-CreER/wt}$:$R26^{RFP}$ mice were recovered for 60 days followed by acoustic trauma to distinguish and define the heterogeneity in CX_3CR1-expressing resident and recruited macrophages in the injured cochlea. Tissue was analyzed by flow cytometry, fluorescent immunohistochemistry, and confocal imaging. After the 60-day recovery period, CX_3CR1 resident macrophages (YFP+ RFP+) and CX_3CR1 lineage recruited macrophages (YFP+ RFP-) expressed differential fluorescent labeling. The examination of the Cre-recombined resident (98 ±1.7% recombination efficiency) and recruited (2.5±1.1% recombination efficiency) macrophages in the normal cochlea for one year indicate that resident macrophages have a much slower turnover rate than recruited macrophages (1-3 days). Following acoustic trauma in Cre recombined mice, there are resident and recruited macrophages in the spiral ganglion and spiral lamina, compared to sham exposed mice which had only resident macrophages present. Increase in macrophage quantity following acoustic trauma is attributed to infiltration of circulating macrophages, macrophage migration, and *in-situ* proliferation of resident macrophages. Macrophage morphometric analysis indicates that morphology is a poor indicator to distinguish CX_3CR1-expressing resident and recruited macrophages in the noise-injured cochlea. Overall, results indicate our fate mapping model effectively distinguishes resident from recruited macrophages allowing us to understand macrophage heterogeneity in normal and injured cochlea.

NEURONAL AND BEHAVIORAL EFFECTS OF CPTII DEFICIENCY MODELED IN ZEBRAFISH

Aaron Marta[1], Carly Baker[2], Nathan Zimmerman[1], Ken Kramer[2], Holly Stessman[3], Annemarie Shibata[1]
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1 - Department of Biology, Creighton University, Omaha, NE;
2 - Department of Biomedical Sciences, Creighton University, Omaha, NE;
3 – Department Pharmacology and Neuroscience, Creighton University, Omaha, NE.

During early development, LCFA metabolism via beta-oxidation is the preferred pathway for energy supplementation. In normal LCFA catabolism, the carnitine shuttle protein carnitine palmitoyltransferase II (CPTII), facilitates the conversion of palmitoylcarnitine to palmitoyl-CoA. A deficiency of the CPT II protein results in the disruption of LCFA catabolism and leads to pathology characterized by neurodevelopmental abnormalities, muscle weakness, and reduced fatty acid oxidation. The mechanism for how CPT II deficiency contributes to neuropsychological disorders is not known. We hypothesize that CPT II deficiency prevents proper brain and whole-body development as the result of dysfunctional metabolic signaling. Using a zebrafish model system to study the effect of CPT II deficiency on brain development and behavior, we knocked down CPT II expression in wildtype (WT) TuAB zebrafish during early development. Splice blocking (SB) and translation blocking (TB) morpholino constructs specific for CPTII were injected into single-cell stage fertilized TuAB zebrafish embryos. Knockdown of CPTII in our conditions was confirmed using PCR. Using Zebrabox behavioral equipment, we ran behavioral quantization and tracking experiments of 5 days post fertilization (dpf) larvae and found significant differences in CPTII knockdown model systems. Behaviors were found to be significantly different for the SB condition when compared to wildtype and control scrambled (sc) morpholino injected fish. Normal movement count was significantly decreased in the SB condition by 874.3 ± 191.2 (±36.02, $p < 0.0001$, N= 96) in the SB condition as compared to control. The duration of small distance movement was significantly decreased in the SB condition by 204.3s ± 47.40s (±48.22 s, $p = 0.0001$, N=106) as compared to controls. The distance for large movement was significantly increased in the SB condition by 11722 nm ± 2411nm (±1788 nm, $p < 0.0001$, N=106) as compared to controls. Huc/d and acetylated tubulin immunohistochemistry counterstained with DAPI highlight structural neuronal and neural network differences. Further studies will explore neural network implications of CPTII deficiency using electrophysiology analyses.

This publication was made possible by grants from the National Institute for General Medical Science (NIGMS) (5P20GM103427 and NOT-GM-21-016), 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.

MACHINE LEARNING APPROACH FOR PREDICTING FLOWERING DAYS IN SORGHUM

Aime Nishimwe[1], Ravi Mural[1], Mackenzie Zwiener[1], Marcin Grzybowski[1], Yufeng Ge[1], James Schnable[1], anishimwe@huskers.unl.edu

1. Department of Agronomy and Horticulture, University of Nebraska, Lincoln, NE

Sorghum is an important cereal crop grown across the globe for its grain and biomass value. It can also efficiently use resources such as nitrogen, and multiple varieties that are nitrogen-use and light-capture efficient are constantly being developed. This study focuses on using the spectral signature of sorghum varieties to predict flowering days, which could be used as a proxy for plants' growth/productivity and development trends, thus helping breeders make quick decisions about what varieties to move to the next stage. Multiple sorghum varieties from the sorghum association panel were planted in a replicate-design field experiment with the variable supply of nitrogen. The flowering days were monitored and recorded. The hyperspectral reflectance data were collected to build a sorghum flowering days predictive model. Although regression models such as partial least square have been used to predict plants' phenotypes, the non-parametric ensemble machine learning models have the potential to outperform linear models given the nature of spectral data. In this study, we train and test various ensemble models and evaluates them on a completely different dataset. Among the models trained, there include – Random Forest, AdaBoost, Gradient Boosting, and Extra Trees. Several metrics were used to judge the performance of these models, and these include – coefficient of determination, explained variance, and mean squared error. We then use these models to predict flowering days in maize species to evaluate their transferability and generalizability to other plant species.

IMPACT OF RADIOTHERAPY AND CHEMOTHERAPY ON NEURONAL CELLS

Destiny Jordan[1,2], Yohan Walters[3], Anne Hubbard[3], Andrew Ekpenyong[3],
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1 - Department of Biology, Creighton University, Omaha, NE;
2 - Department of Chemistry, Creighton University, Omaha, NE;
3 - Department of Physics, Creighton Univ, Omaha, NE.

Neuroblastoma is the most common malignant tumor in children. By the time of diagnosis, the cancer has often metastasized to other areas of the body, such as lymph nodes, bones, bone marrow, liver, and skin. Common treatments for neuroblastoma include chemotherapy and radiotherapy, which are given to neutralize the cancerous cells. As these treatments target the cancer cells but not their metastasis, the inadvertent prometastatic effects of these treatments are beginning to emerge. These inadvertent effects are the foci of this study. Here, we use an Electric Cell-substrate Impedance Sensing (ECIS) device to measure the migration (metastasis) and growth of SH-SY5Y and PC-12 cells, cancerous and non-cancerous neuronal cells respectively. Previously, we employed microfluidic microcirculation mimetic (MMM) devices to examine the effects of chemotherapy on metastasis. We discovered that leukemic cancer cells treated with doxorubicin and daunorubicin displayed enhanced retention in the microcirculation, a key step in the metastatic cascade, and enhanced migration following chemotherapy. Bearing in mind that over 90% of all cancer deaths are caused by metastasis, this display of pro-metastatic effects after chemotherapeutic treatment highlights the urgent need for anti-metastasis therapy, as both chemo- and radiotherapy target the proliferation of cancer. This work has the potential to be a substantial 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.

CHARACTERIZATION OF THE K. LACTIS SPINDLE POLE BODY

Zachary Rinke[1], Ann Cavanaugh-Coauthor[1], zacharyrinke@creighton.edu
1 - Department of Biology, Creighton University, Omaha, NE

Microtubule organizing centers (MTOCs) are essential components of most eukaryotic cells. The MTOCs of yeast are large protein complexes called spindle pole bodies (SPBs). The structure and localization of SPBs are remarkably variable among different species of yeast. The goal of this study is to explore the structural evolution of yeast SPBs in two taxonomically close species of yeast, *Saccharomyces cerevisiae* and *Kluyveromyces lactis*. We are analyzing *K. lactis* SPB proteins by individually tagging the *K. lactis* homologs of each *S. cerevisiae* SPB protein with green fluorescent protein (GFP) and analyzing their localization in *K. lactis*. We are confirming the localization of each *K. lactis* homolog to the SPB or noting significant differences in localization using confocal microscopy. We are further analyzing the *K. lactis* SPB proteins by assessing the ability of each *K. lactis* homolog to replace *S. cerevisiae* SPB proteins in *S. cerevisiae* deletion strains. We are using GFP to confirm correct substitution and localization of *K. lactis* SPB proteins within the *S. cerevisiae* cell. In the future we will continue testing all 18 *K. lactis* SPB homologs for localization to the SPB and rescue capability within *S. cerevisiae*. Analysis of regions and proteins conserved, or variable, will provide valuable insight into SPB evolution and evolution of proteins in general.

CHEMISTRY SECTION Chairperson: **Nathanael Fackler**

FRIDAY, APRIL 22 Location: **Room 207 Acklie Hall**

MORNING SESSION

9:00 *ZOOM*

Session opens for participants to join. On-line participants: Please enable sound only if you are presenting and during the question period. In-Person Participants: The meeting room is equipped with a microphone and camera. If you are also attending virtually, please mute your sound to avoid local microphone feedback.

https://nebrwesleyan.zoom.us/j/92736199473?pwd=NkJ4ditxR1JRKzBNeDNlQmNSbDM2QT09

If you need assistance connecting via Zoom, or finding the right session, please contact UNL's CSMCE Home Room Support team

9:15 MITIGATION OF TOOTH DISCOLORATION AND ENAMEL EROSION FROM CHEWING TOBACCO. Riley Hill and Mary Keithly (abstract)

9:30 FABRICATION OF AU STENCIL-PRINTED PLANAR ELECTRODES FOR THE DEVELOPMENT OF NUCLEIC ACID BIOSENSORS. Samaya Kallepalli, Jacob Benes, Erin M. Gross, Kenneth Hipp, Rebecca Y. Lai (abstract)

9:45 HYDROLYZABLE LINKER-MODIFIED KETOSES FOR PERDURIBLE INSECT REPELLENTS: A SYNTHESIS OF DIMETHYLAMINOETHYL ETHERS OF 1,3-DIHYDROXYACETONE. Karolina Rooney and Martin Hulce (abstract)

10:00 IMPROVING ELEPHANT TOOTHPASTE AS AN EDUCATIONAL DEMONSTRATION. Jared Nelson, Tim Keith (abstract)

10:15 ENGINEERING GENETICALLY ENCODED BIOSENSORS FOR 3-HYDROXYBUTRYIC ACID AND 3-HYDROXYVALERIC ACID. Mia Morrissey and Benjamin Brandsen (abstract)

10:30 USING RAMAN SPECTROSCOPY TO VIEW CARBON MONOXIDE AND NITRITE BINDING TO HEME ON GOLD NANOPARTICLE PLATFORMS Alexis Burke and Dr. Chris Huber (abstract)

10:45 ENGINEERING GENETICALLY ENCODED BIOSENSORS FOR THE HERBICIDE DICAMBA. Abbie Manse, Chase McCollum, and Benjamin Brandsen (abstract)

11:00-12:00 **MAIBEN LECTURE** **Olin Hall Lecture Hall 'B'**
https://unl.zoom.us/j/9289316099

Dan Sitzman, Lecture Title: *History of the Nebraska Academy of Sciences*

12:00-12:30 **BUSINESS MEETING** **Olin Hall Lecture Hall 'B'**
https://unl.zoom.us/j/9289316099
Nebraska Academy of Sciences (all members)
State of the Academy
Awards Ceremony
Comments from Members-at-Large

12:30 – 1:30 **LUNCH** Student Center Cafeteria (pre-purchase ticket or pay-at-door)

1:00 – 1:20 ***NAS Future Leaders Panel*** in the **Sunflower Room** (Student Center by the Cafeteria) join the informal discussion to learn how you can help lead NAS into the future

POSTER SESSION
Smith Curtis Great Hall (Second Floor)

Posters should available for review from 1:30 – 3:15 but may be displayed all day. Presenters are encouraged to be available between 2:30 – 3:00 to present their work to any interested meeting attendees.

CHEM-1 NO(A) RECOIL ANISOTROPY FROM PHOTODISSOCIATION OF THE N_2-NO COMPLEX. Marcos Rivera, Michael Onder, Hunter Warder, Adrien Draney, and Bradley Parsons (abstract)

CHEM-2 SYNTHESIS OF ALLENYL ALCOHOLS AND AMINES BY REGIOSELECTIVE 1,4-HYDRIDE REDUCTIONS. Martin Hulce, Jordanne Orlowski, and Brad Young (abstract)

CHEM-3 MITIGATION OF TOOTH DISCOLORATION AND ENAMEL EROSION FROM CHEWING TOBACCO. Riley Hill and Mary Keithly (abstract)

5:00 – 7:00 **SOCIAL EVENT** at **LUX Center for the Arts**
Meet with colleagues, make connections, socialize; snacks and soft-drinks, and a cash-donation bar 2601 N. 48th Street, two blocks away https://www.luxcenter.org/

MITIGATION OF TOOTH DISCOLORATION AND ENAMEL EROSION FROM CHEWING TOBACCO

Riley Hill[1], Mary Keithly[1], riley.hill@eagles.csc.edu

1. Department of Mathematical and Natural Sciences Chadron State College, Chadron, NE

The harmful side-effects on the oral cavity caused from consistent use of chewing tobacco are common knowledge, but means of mitigation are not. Chewing tobacco contains Nicotine, a highly addictive chemical that becomes trapped in the pores of teeth, causing tooth discoloration and enamel erosion. The goal of this experiment was to determine which of two dentist recommended brands of toothpaste best prevent tooth discoloration and enamel erosion when exposed to chewing tobacco. The two toothpaste brands chosen for this experiment were Crest Pro-Health and Sensodyne Pro-Enamel based on varying levels of fluoride content. Copenhagen Long-cut Original and Skoal Long-cut Wintergreen chewing tobacco contain differing amounts of nicotine and sugar, allowing us to compare the effects of nicotine and sugar content. Bovine teeth, which are extremely similar to human teeth based on bond strength and chemical composition, were exposed to each brand of tobacco over a six-week period. The teeth were brushed for 30 seconds each day, for a total of 24 days. At the end of experimentation, all teeth displayed a decrease in mass, indicating that enamel erosion may have occurred. Based on careful observation, the results displayed less discoloration amongst the experimental groups exposed to the Crest Pro-Health Toothpaste. The teeth exposed to Skoal Long-cut Wintergreen resulted in a higher degree of discoloration than the teeth exposed to Copenhagen Long-cut Original. The analysis of the tooth discoloration results is still ongoing, as a computer program will be used to obtain a quantitative value of discoloration amongst each set of teeth. These results provide strong evidence that Crest Pro-Health is an effective toothpaste in terms of mitigating tooth discoloration and enamel erosion from chewing tobacco.

FABRICATION OF AU STENCIL-PRINTED PLANAR ELECTRODES FOR THE DEVELOPMENT OF NUCLEIC ACID BIOSENSORS

Samaya Kallepalli[1], Jacob Benes[1], Erin M. Gross[1], Kenneth Hipp[2], Rebecca Y. Lai[2], skallepalli633@gmail.com

1 - Department of Chemistry & Biochemistry, Creighton University, Omaha, NE 68178

2 - Department of Chemistry, University of Nebraska, 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 commercial Au-electrodes stability. We determined the optimal alkanethiol chain length and applied potential to use in folding-based ECL nucleic acid biosensors. However, some sensors still exhibited irreproducibility under some experimental conditions. It is crucial to develop an electrochemical cell that would consistently reproduce data. Thus, the development of stencil-printed electrodes has shown promise to replace the commercial electrochemical cell. This study investigated stencil-printed electrodes in the fabrication of the electrode and the Au-plating of the electrodes. The electrodes were fabricated using a graphite paste and a stencil-printing squeegee onto a 3D-printed polylactic-acid plastic plate. The electrode plate displays a complete electrochemical cell, including reference, counter, and working electrode counterparts. The Au-plating fabrication conditions were optimized. Fabrication was achieved through a reduction reaction of a $HAuCl_4$, or Au^{3+} solution, in conjugation with applied potential, in which the electrode was submerged. Through literature searches and analytical trial and error, the optimal potential applied was determined to be -0.2 V, and the optimal solvent for fabrication of the Au^{3+} solution was successful in a 0.5 M H_2SO_4 solution. The time of potential application and Au^{3+} solution concentrations was systematically investigated through optical microscopy and scanning electron microscopy (SEM). We found the time for Au-plating to be applied at the potential of -0.2 V for no more than 180 seconds. Lastly, Au-plating with the conditions of 5, 10, 15, and 20 mM Au^{3+} concentrations were systematically optimized. It was determined that a concentration range of 5 to 10 mM of the $HAuCl_4$ in 0.5 M H_2SO_4 seemed to be the most optimal conditions, as any concentration above 10 mM fabricated Au onto the reference electrode, making the reference electrode nonfunctional. The optimal conditions for fabrication were submersion in a 5 to 10 mM Au solution for no more than 180 seconds. Further analysis of the fabrication of the Au was achieved through SEM and optical microscopy. We will determine the optimal conditions to use for folding-based ECL nucleic acid biosensors through this work.

HYDROLYZABLE LINKER-MODIFIED KETOSES FOR PERDURIBLE INSECT REPELLENTS: A SYNTHESIS OF DIMETHYLAMINOETHYL ETHERS OF 1,3-DIHYDROXYACETONE

Karolina Rooney, Martin Hulce, karolinarooney@creighton.edu
Department of Chemistry, Creighton University, Omaha, NE

With the growth of disease spread by insects, the existence of efficient and sustainable insect repellents has become increasingly important. However, with time the effectiveness of insect repellents decreases. Therefore, it is beneficial to explore the synthesis of an insect repellent that lasts longer by attaching the repellent to a hydrolyzable skin bonding agent. Specifically, 2,5-diethoxy-3,5-di(hydroxymethyl)-1,4-dioxane was formed which is a protected version of 1,3-dihydroxyacetone, known to bond to skin. While the Williamson ether synthesis to benzylate this sugar was successfully accomplished, the etherification of the hemiacetal with (2-chloroethyl)-dimethylamine was unsuccessful. To find the proper reaction conditions for etherification, a simpler, more soluble but sterically similar model molecule, neopentyl alcohol, was used. A variety of ether syntheses including variations of the Williamson ether synthesis were investigated to prepare 2-(dimethylamino)ethyl neopentyl ether.

Improving Elephant Toothpaste as an Educational Demonstration

Jared Nelson, Tim Keith, jared.nelson1@eagles.csc.edu
1 - Department of Chemistry, Chadron State College, Chadron, NE;

Elephant toothpaste is a common educational demonstration that can be used at all levels of education to display a variety of chemistry concepts. The reaction uses hydrogen peroxide, a catalyst, and soap. The catalyst exacerbates the decomposition of hydrogen peroxide into water and oxygen, and the soap traps the oxygen creating foam. The elephant toothpaste demonstration can be done using many different materials to obtain the same outcome. The purpose of this study is to examine how different peroxide concentrations and catalysts effect the reaction rate of the demonstration and compare typical lab material with store-bought materials to find the most cost effective and accessible way to do the demonstration. The reaction rate of two catalysts (Potassium Iodide, dry yeast,) and four concentrations of hydrogen peroxide (30%, 20%, 10%, and 3%) was determined by calculating the time it took for the reaction to reach a specified distance. The reaction rate of the 3% hydrogen peroxide and yeast catalyst was found to be only 0.017 in./sec. Additional research is ongoing with different concentrations.

ENGINEERING GENETICALLY ENCODED BIOSENSORS FOR 3-HYDROXYBUTRYIC ACID AND 3-HYDROXYVALERIC ACID

Mia Morrissey[1], Benjamin Brandsen[1], miamorrissey@creighton.edu
1 - Department of Chemistry and Biochemistry, Creighton University, Omaha, NE.

Genetically encoded biosensors convert the concentration of an intracellular metabolite into an observable genetic response, such as an increase in fluorescence or change in cellular growth rate. Biosensors are useful for optimizing the activity of biosynthetic pathways, allowing large-scale mutagenesis and selection on metabolic pathways to optimize production of key chemical compounds. One rich source of biosensors is naturally occurring allosteric transcription factors, which bind to their ligand and regulate expression of downstream genes. Identification of biosensors for new ligands is challenging, however, especially when a naturally occurring transcription factor is not already known. Here we report our efforts to engineer the allosteric transcription factor BenM to respond to the ligands 3-hydroxybutyric acid and 3-hydroxyvaleric acid, key components of polyhydroxyalkanoate polymers. We generated a library of variants of BenM using error-prone PCR, optimized conditions for positive and negative selection of BenM, and performed a selection experiment to enrich this library with BenM variants that respond to these target ligands. Our efforts demonstrate one approach to engineer biosensors that respond to new ligands.

USING RAMAN SPECTROSCOPY TO VIEW CARBON MONOXIDE AND NITRITE BINDING TO HEME ON GOLD NANOPARTICLE PLATFORMS

Alexis Burke[1], Dr. Chris Huber[1], lexi.burke@doane.edu
1 - Department of Chemistry, Doane University, Crete, NE

Heme is the iron complex in the blood, a specific part of hemoglobin that bonds to both oxygen and carbon dioxide and is crucial to the respiratory system's function. Using Raman spectroscopy, a type of spectroscopy utilizing vibrations to record and visualize bonds within molecules, the iron of heme bonding with oxygen and nitrite can be examined. In this study, heme complexes were attached to gold nanoparticles (AuNPs) to help amplify the typically weak Raman signatures. This technique is referred to as Surface-Enhanced Raman Spectroscopy (SERS). A home-built Raman spectrometer was used to collect the SERS spectra at an excitation of 785 nm. The SERS spectra demonstrate the successful binding of the heme compound to the AuNPs. Additionally, the SERS spectra can respond successfully to the oxidation and reduction of the heme complex. We can track interactions between heme complexes and certain small molecules, such as carbon monoxide and nitrite.

ENGINEERING GENETICALLY ENCODED BIOSENSORS FOR THE HERBICIDE DICAMBA

Abbie Manse[1], Chase McCollum[1], Benjamin Brandsen[1], abbiemanse@creighton.edu
1 - Department of Chemistry and Biochemistry, Creighton University, Omaha, NE.

Engineered microorganisms and plants promise to address the challenges we face in detecting contaminants in our water systems. Biosensors are one technology that can greatly facilitate development of these engineer biological systems. Despite their promise, however, biosensors are relatively challenging to engineer for new chemical ligands. Here, we share our efforts to develop a biosensor based on the AraC transcription factor from *E. coli* that responds to the herbicide dicamba. By coupling a fluorescent reporter gene to the promoter of AraC and screening for variants of AraC that show increased fluorescence in the presence of dicamba, we have identified several candidate biosensors that contain unique amino acid mutations. These biosensors show a modest two-fold response to dicamba, but in most cases have lost their response to their native ligand L-arabinose. We are currently performing additional rounds of directed evolution to improve their response to dicamba, with the hopes of engineering biosensors sensitive enough to detect dicamba in natural water systems.

NO(A) RECOIL ANISOTROPY FROM PHOTODISSOCIATION OF THE N_2-NO COMPLEX.

Marcos Rivera[1], Michael Onder[1], Hunter Warder[1], Adrien Draney[1], Bradley Parsons[1], mrr02622@creighton.edu

1 - Department of Chemistry and Biochemistry, Creighton University, Omaha, NE.

We used velocity map ion imaging to measure the angular anisotropy of the NO (A) products from photodissociation of the N_2-NO complex. Photodissociation of the complex forms NO (A) + N_2 (X) products, and the former showed a strong recoil angular anisotropy. Near the photodissociation threshold, we found NO (A) to have an average anisotropy parameter, $\beta = -0.25$, indicating NO (A) preferentially recoiling perpendicular to the laser polarization axis. However, as the available energy increased, by decreasing the laser wavelength, the observed recoil anisotropy parameter increased. Thus, far above threshold, we found $\beta = +0.28$, indicating a more parallel angular distribution. We also observed a large contribution from hotband excitation at the lowest available energy, but the contribution decreased with increasing energy. The hotband contribution at the lowest available energy may provide better Franck-Condon overlap to more easily access the minimum excited electronic state region near threshold. Lastly, we use a statistical kinetic energy distribution to contrast with our experimental center of mass translational energy distribution. The experimental and statistical energy distributions show large disagreement, with the experimental showing a lower probability of forming fragments with high rotational energy.

SYNTHESIS OF ALLENYL ALCOHOLS AND AMINES BY REGIOSELECTIVE 1,4-HYDRIDE REDUCTIONS

Martin Hulce, Jordanne Orlowski, and Brad Young, mhulce@creighton.edu
Department of Chemistry and Biochemistry, Creighton University, Omaha, NE.

Allenes are useful building blocks in organic synthesis: They permit a variety of synthetic transformations, serve as ligands for organometallic catalysts and are essential structural motifs in drugs. Tandem 1,2 - 1,4 double hydride addition to 3-alkynyl-2-alkenones provides allenyl alcohols from alkenynones, but may have variable diastereoselectivity in the second 1,4-hydride addition step. To determine if sterically bulky hydride donors increase diastereoselectivity in the second addition step, a Mosher analysis protocol was designed and deployed to quantify enantio- and diastereoselectivity of the reaction. 3-Alkynyl-2-alkenamines, prepared by reductive amination of 3-alkynyl-2-alkenones, were also investigated as substrates for diastereoselective 1,4-hydride addition.

MITIGATION OF TOOTH DISCOLORATION AND ENAMEL EROSION FROM CHEWING TOBACCO

Riley Hill[1], Mary Keithly[1], riley.hill@eagles.csc.edu

1. Department of Mathematical and Natural Sciences Chadron State College, Chadron, NE

The harmful side-effects on the oral cavity caused from consistent use of chewing tobacco are common knowledge, but means of mitigation are not. Chewing tobacco contains Nicotine, a highly addictive chemical that becomes trapped in the pores of teeth, causing tooth discoloration and enamel erosion. The goal of this experiment was to determine which of two dentist recommended brands of toothpaste best prevent tooth discoloration and enamel erosion when exposed to chewing tobacco. The two toothpaste brands chosen for this experiment were Crest Pro-Health and Sensodyne Pro-Enamel based on varying levels of fluoride content. Copenhagen Long-cut Original and Skoal Long-cut Wintergreen chewing tobacco contain differing amounts of nicotine and sugar, allowing us to compare the effects of nicotine and sugar content. Bovine teeth, which are extremely similar to human teeth based on bond strength and chemical composition, were exposed to each brand of tobacco over a six-week period. The teeth were brushed for 30 seconds each day, for a total of 24 days. At the end of experimentation, all teeth displayed a decrease in mass, indicating that enamel erosion may have occurred. Based on careful observation, the results displayed less discoloration amongst the experimental groups exposed to the Crest Pro-Health Toothpaste. The teeth exposed to Skoal Long-cut Wintergreen resulted in a higher degree of discoloration than the teeth exposed to Copenhagen Long-cut Original. The analysis of the tooth discoloration results is still ongoing, as a computer program will be used to obtain a quantitative value of discoloration amongst each set of teeth. These results provide strong evidence that Crest Pro-Health is an effective toothpaste in terms of mitigating tooth discoloration and enamel erosion from chewing tobacco.

EARTH SCIENCES SECTION Chairperson: **Irina Filina**

FRIDAY, APRIL 22 **Location: Room A211 Acklie Hall**

MORNING SESSION - 1 Chairs: **Irina Filina** and **Ross Dixon**

ZOOM Session opens for participants to join at 8:25
https://unl.zoom.us/j/97679797295?pwd=N0cwbzZoS1l5cHY2T3FpeW9ZNjE0Zz09
Passcode: 762128

If you need assistance connecting via Zoom, or finding the right session, please contact UNL's CSMCE Home Room Support team

8:25 Presenters upload talks from USB drives onto the room computer desktop.

8:30 INTERACTION WITH AUGMENTED REALITY SANDBOX DOES NOT PRODUCE GREATER GAINS IN TOPOGRAPHIC MAP SKILLS FOR UNDERGRADUATE STUDENTS. Celeste S. Kenworthy, Mindi L. Searls, Ryan Bockmon, Caroline M. Burberry (abstract)

8:45 CURIOSITY- & QUESTION-DRIVEN APPROACHES USING ONLINE RESOURCES TO ENHANCE GEOSCIENCE STUDENT ENGAGEMENT. David Harwood, Megan Heins, Gosia Mahoney, Eyde Olson (abstract)

9:00 ABLATION SPHERULES IN ANTARCTIC OCEAN SEDIMENT: STRATIGRAPHIC DATING OF DIATOM FOSSILS AND COSMIC DEBRIS IN ROSS SEA SEDIMENT CORES TO ASSESS AND DATE THE INTENSIFICATION OF ANTARCTIC GLACIATION. Rylan Chilcott, David M. Harwood, Scoie Daringer, Emily Seifferlein (abstract)

9:15 THE DIATOM DARK AGES: IDENTIFICATION OF MID-CRETACEOUS ARCTIC PLATFORM DIATOMS FROM BASAL TRANSGRESSIONS OF THE KANGUK FORMATION, DEVON ISLAND, NUNAVUT, CANADA. Megan Heins, David Harwood (abstract)

9:30 **BREAK**
During break - Presenters upload talks from USB drives onto the room computer desktop.

MORNING SESSION - 2 Chairs: **Irina Filina** and **Ross Dixon**

https://unl.zoom.us/j/97679797295?pwd=N0cwbzZoS1l5cHY2T3FpeW9ZNjE0Zz09
Passcode: 762128

9:45 BIASES IN RAIN-ON-SNOW EVENTS IN CLIMATE MODELS. Ross Dixon, Tirthankar Roy (abstract)

10:00 AN INVESTIGATION OF WATER OBSTRUCTIONS AND RELATED WEATHER CONDITIONS FOR NEBRASKA ROADWAYS. Logan Bundy, Mark R. Anderson (abstract)

10:15 CAUSES AND MITIGATION OF IRON DEFICIENCY CHLOROSIS IN SOYBEANS (GLYCINE MAX). Spencer Knuth, Jeffrey Kiiskila, Mary Keithly (abstract)

10:30 WATER SAMPLING FOR THE KNOW YOUR WELL PROJECT IN NORTHWESTERN NEBRASKA. Corey Griffin, Tawny Tibbits, Michael Leite, Mary Kiethly (abstract)

10:45 AN ASSESSMENT OF USDA CORN CONDITION RATINGS ACROSS THE U.S. CORN BELT. Logan Bundy, Vittorio A. Gensini (abstract)

11:00-12:00 **MAIBEN LECTURE** **Olin Hall Lecture Hall 'B'**
https://unl.zoom.us/j/9289316099

Dan Sitzman, Lecture Title: *History of the Nebraska Academy of Sciences*

12:00-12:30 **BUSINESS MEETING** **Olin Hall Lecture Hall 'B'**
https://unl.zoom.us/j/9289316099
Nebraska Academy of Sciences (all members)
State of the Academy
Awards Ceremony
Comments from Members-at-Large

12:30 – 1:30 **LUNCH** Student Center Cafeteria (pre-purchase ticket or pay-at-door)

1:00 – 1:20 ***NAS Future Leaders Panel*** in the **Sunflower Room** (Student Center by the Cafeteria) join the informal discussion to learn how you can help lead NAS into the future

AFTERNOON SESSION - 3 Chairs: **Irina Filina** and **Nicholas Richard**

1:25 Presenters upload talks from USB drives onto the room computer desktop
ZOOM Session opens for participants to join at 1:25
https://unl.zoom.us/j/97679797295?pwd=N0cwbzZoS1l5cHY2T3FpeW9ZNjE0Zz09
Passcode: 762128

1:30 OIL POTENTIAL IN WESTERN NEBRASKA. Robert Logan Tiensvold, Michael Leite (abstract)

1:45 FINALIZING NEW GRAVITY BASE STATIONS ON THE UNL CITY CAMPUS. Kris Guthrie, Irina Filina (abstract)

2:00 SUMMARIZING SCIENTIFIC DRILLING RESULTS OVER CASCADIA SUBDUCTION ZONE. Morgan Madsen, Irina Filina (abstract)

2:10 PROCESSING SEISMIC, GRAVITY AND MAGNETIC DATA OVER DIEBOLD KNOLL ON JUAN DE FUCA PLATE Md Ariful Islam, Irina Filina (abstract)

2:25 **BREAK**

2:30 INTERPRETING THE MANTLE SOURCE OF CENOZOIC BASALTS FROM SOUTH-CENTRAL VIETNAM USING RADIOGENIC ISOTOPES. Nicholas Richard, Lynne J. Elkins, John C. Lassiter, Caroline M. Burberry, Nguyen Hoang (abstract)

2:45 COMPARING SATELLITE VS MARINE POTENTIAL FIELDS DATA OVER THE BATHYMETRISTS SEAMOUNTS. Alexa Fernandez, Irina Filina (abstract)

3:00 OVERVIEW OF COMPLEX TECTONICS OF THE NORTHERN ATLANTIC. Irina Filina (abstract)

3:10 ANALYZING THE CRUSTAL NATURE OF THE VORING PLATEAU FROM SEISMIC REFRACTION DATA. Jonathan Wear, Irina Filina (abstract)

3:25 Session wrap-up

5:00 – 7:00 **SOCIAL EVENT** at **LUX Center for the Arts**
Meet with colleagues, make connections, socialize; snacks and soft-drinks, and a cash-donation bar 2601 N. 48th Street, two blocks away https://www.luxcenter.org/

INTERACTION WITH AUGMENTED REALITY SANDBOX DOES NOT PRODUCE GREATER GAIN IN TOPOGRAPHIC MAP SKILLS FOR UNDERGRADUATE STUDENTS

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The augmented reality (AR) sandbox allows students to interact with topographic maps in a 3D space. Being able to understand topographic maps is important to geologists and they are taught in many introductory geology courses. Recent research has focused on whether the AR sandbox can improve students' topographic map skills. Previous studies have found that students who interact with the AR sandbox do not score significantly better on topographic map assessments (TMAs) than their peers. One proposed reason for this is the limited time students have to interact with the AR sandbox. This study sought to address this by creating an experimental group that completed a structured activity at the AR sandbox for approximately 30 minutes, an experimental group that engaged in unstructured interaction with the AR sandbox for up to 15 minutes, and a control group that did not interact with the AR sandbox. While all student groups showed significant learning gains on the TMA, there was not a significant difference between students that interacted with the AR sandbox and those that did not. We found no significant difference in scores on the TMA between males and females. We found that self-rated topographic experience was significantly correlated with score on the TMA. We also found that students with a declared STEM major scored significantly higher on the TMA than students with non-STEM major(s). The pre-test TMAs did not follow a normal distribution, an assumption of the statistical analyses used, although we do not expect this impacted our findings. Although this study and previous studies have found that use of the AR sandbox does not improve topographic map learning, a majority of students that used the sandbox said it was their favorite activity and over 97% recommended that the sandbox activity be used in future labs. This project also developed a promising future use for the AR sandbox to improve spatial skills.

CURIOSITY- & QUESTION-DRIVEN APPROACHES USING ONLINE RESOURCES TO ENHANCE GEOSCIENCE STUDENT ENGAGEMENT

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Providing opportunities within formal course structure for students to investigate and relevant geoscience topics of interest to them is presented as a vehicle to enhance student engagement and learning. Exploration and 'mining' internet content, specifically short videos shared and discussed asynchronously with peers. This approach enables students to follow their curiosity and invest in their learning across course-related themes in course GEOL 125: *Frontiers of Antarctic Geosciences* at the University of Nebraska-Lincoln. Students are exposed to a range of rich and visual content that brings Antarctica, scientific research activities, and topical subjects into clear focus. Students conclude each of four themes by developing high-level questions that enhance and focus student discussion boards, fostering enriched and shared learning. Students welcome freedom to explore topics of interest to them within the general flow of course material, and connections made between students with similar interests. *Packback* is an online discussion platform (www.packback.co) that teaches students how to ask effective, open-ended questions about course-related topics of interest to them. Students post one well-developed and supported question per week, prompted by instructor guidance, and provide comments to two questions posted by classmates. Artificial Intelligence within *Packback* advises students' writing skills and curiosity, checks for plagarisim, and provided direct feedback to increase organizational skills. The instructor regards well-developed student-generated questions as perhaps more important than the eventual 'answers', as the ability to frame complex questions is an important step in insightful critical thinking, and discovery of new knowledge. Students pursue what interests them, and instructors highlight and expand upon the best materials students bring forward. Teaching with student-identified content requires that instructors 'let-go' to build upon student curiosity, and add key foundational content in reflection and close-out summaries. These are developmental steps toward personal skillsets and joy in lifelong learning.

ABLATION SPHERULES IN ANTARCTIC OCEAN SEDIMENT: STRATIGRAPHIC DATING OF DIATOM FOSSILS AND COSMIC DEBRIS IN ROSS SEA SEDIMENT CORES TO ASSESS AND DATE THE INTENSIFICATION OF ANTARCTIC GLACIATION.

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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 from three separate sediment coring sites were examined for relative concentration and size variation over stratigraphic time. For two sites, a distinct increase in concentration of spherules was observed at approximately 2.5 million years ago. This approximate time period saw an intensification of glaciation near the Ross Sea area, resulting in invigorated ocean circulation. Size variations among spherule samples was observed, and these are believed to be influenced by changes in ocean current strength, with one site located in the Hillary Canyon and the other two on the Ross Sea Continental Rise. Current scientific understanding of the reasons for Antarctic glaciation and onset of the Quaternary Ice Age in the late Pliocene is still incomplete and requires further study, and trends in spherule distribution can help discussions of glacial/interglacial cycles and Antarctic Ocean depositional environments. An alternative explanation for the micro-spherules is that they derive from a meteorite impact event that vaporized marine sediments, which should carry a unique geochemical fingerprint. 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. 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. 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. 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. Diatom biostratigraphy in paired sediment samples will provide age control for depositional sequences.

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

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The mid-Cretaceous presents us with many different questions surrounding marine diatom evolution, environmental distribution, and paleoecology. Diatom assemblages have been studied extensively from the late Cretaceous onwards, though not much is known about the mid-Cretaceous 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 of this 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 will lead to the proposal of new questions and hypotheses about the area of study. As these diatom floras are poorly known, this research project will involve description of new taxa, resolving taxonomic problems, and bringing these fossil diatom floras into a modern system of classification. Preliminary analysis has allowed us to identify various diatom taxa and start to formulate the baseline for our diatom classification scheme. This study will lead to the application of marine diatoms in biostratigraphic and paleoecological studies of diatoms across the Arctic Platform and Sverdrup Basin. As preservation of the diatom assemblages from Devon Island is excellent, this site will become an important reference section for future diatom studies.

BIASES IN RAIN-ON-SNOW EVENTS IN CLIMATE MODELS

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When rain falls on a snowpack, a Rain-on-Snow (ROS) event, the combination of rain and snowmelt can lead to severe hazards such as flooding, avalanches, and landslides. ROS events are a forecasting challenge as they often produce larger flooding events than expected. “Why, how, and when do rain-on-snow events produce exceptional runoff?” is one of the unsolved questions in hydrology (Blochel et al. 2019). How ROS events may change in the future has been explored in regional climate simulations (e.g. Jeong and Sushama 2018), but our confidence in these projections depends on how ROS events are represented in climate models during the historical period. In this study we use observational data from 1982 to 2011 to characterize ROS days over North America. We then use the same methodology to detect ROS days during the same time period for simulations in the Coupled Model Intercomparison Project Phase 6 (CMIP6). For the region east of the Rocky Mountains, the CMIP6 simulations tend to produce fewer ROS days than the observational data and produce different trends in the number of ROS days. Finally, we consider simulations with fixed sea surface temperatures, higher resolutions, and regional domains in order to hypothesize which physical processes drive these biases.

AN INVESTIGATION OF WATER OBSTRUCTIONS AND RELATED WEATHER CONDITIONS FOR NEBRASKA ROADWAYS

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Roadway resilience across the 10,000 miles of road and 3,500 bridges in Nebraska is critical to the economic success of production and logistics. In a state where historical flooding scenarios, such as the one in March 2019 that caused $150 million in damage, could potentially be on the increase, it has become essential to spatially and temporally understand high-frequency water obstruction areas on roadways. Using Nebraska Department of Transportation historical water obstruction data from June 2016 through August 2021, this research performed statistical and spatial analyses on Nebraska state and federal roadway water obstruction data, quantified the relationship between water obstructions and their associated meteorological conditions, and identified the potential linkages between water obstructions and climate patterns. Within the study period, 298 total unique water obstructions occurred, 174 came from March 2019, and 225 in total coming from 2019 alone. On a median basis, Nebraska experiences 13 water obstructions annually and occur primarily in the summer season. Groundwater, ice jamming, and long- and short-duration precipitation obstructions have occurred the most in the northern and eastern domains of Nebraska. There is a greater risk of water obstructions occurring at specific reoccurrence locations given the exposure to the weather-related hazards on average, and the higher density of roadways that are exposed to rivers such as the Elkhorn and Platte that have more water obstructions than elsewhere. A key finding in this analysis was that water obstructions over the study period were closely related with 30-year climatological data, which can then be used for water obstruction risk assessment on a seasonal and annual basis. A fundamental understanding of the water obstruction spatiotemporal climatology, knowledge of where water obstructions have occurred the most, and identifying the precursor and future meteorological conditions, a more proactive approach can be taken in the onset of potential water obstructions. Further, the identification of the high-frequency water obstruction locations can be considered for mitigation efforts to increase the resiliency of travel from water obstructions.

CAUSES AND MITIGATION OPTOIONS OF IRON DEFICIENCY CHLOROSIS IN SOYBEANS *(GLYCINE MAX)*

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Iron deficiency chlorosis (IDC) is a disease which is characterized by a plant's inability to absorb adequate iron from the soil. Plants with IDC commonly exhibit interveinal chlorosis of leaf blades, low plant vigor, and decreased yield potential. Iron deficiencies can affect cash crops, such as Soybeans (*Glycine max*), decreasing overall revenue. Scientists have developed new hybrids in recent decades to lessen the effects of IDC. Despite these scientific advancements in plant genetics, IDC remains a largely unsolved challenge faced by many producers. The main cause of IDC can vary from field to field. As a result, identifying a specific strategy to mitigate the prevalence of IDC is challenging. This study's objective was to identify the main factor(s) contributing to *Glycine max* iron chlorosis on an operation in south central Nebraska. High pH soils combined with the application of carbonate-rich irrigation water were expected to be the main factors contributing to decreased plant health. For testing, samples of groundwater, soil, and leaf tissue were collected during the growing season and sent for analysis. Quantitative data was then analyzed to find correlations between field conditions and IDC prevalence. Preliminary analysis of results found soils to have pH ranges from 7.1-8.2 with a strong correlation between high lime concentrations and IDC issues. Soils with higher organic matter (greater than 2% by mass) were found to have lower pH values. Water samples had pH values of 7.8-8.2 and a high concentration of calcium carbonate. High levels of manganese and zinc was found in plant tissue samples indicating that iron transport processes were being inhibited within the plant. Increasing organic matter by planting cover crops during the non-growing season may aid in decreasing soil pH. Additionally, the use of metal hyperaccumulating plants could decrease the prevalence of excess transition metals in the soil.

WATER SAMPLING FOR THE KNOW YOUR WELL PROJECT IN NORTHWESTERN NEBRASKA

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Residents of Dawes, County, Nebraska, like most regions of the state, are heavily reliant on groundwater for domestic use, and groundwater is pumped from a variety of aquifers, from the basal White River Group to a diverse mix of shallow alluvial units. While the potential for contamination exists whenever groundwater is accessed, certain geological and land-use scenarios are more conducive to contamination. In this area, possible sources include volcanic-ash derived heavy metals including uranium, arsenic, cadmium, and lead. Even in a region dominated by grazing, nitrate pollution is a risk, and previous work has drawn a correlation between elevated nitrate and leaching of heavy metals from aquifers. Pesticides from domestic and agricultural sources are also a risk that should be assessed when testing water. Despite the heavy use of groundwater for private water sources, there are sparse data from this area documenting the quality of water from private wells. The Know Your Well Project, funded by the US Geological Survey through the Nebraska Water Center at the University of Nebraska at Lincoln, has provided funding and educational opportunities for Chadron State College, Chadron High School, and Crawford High School to collect water from private wells and build a database. Although the Know Your Well Project began in 2017, Northwestern Nebraska did not receive resources to begin data collection until 2021 and did not start data collection until 2022. Contaminants and properties tested include pH, conductivity, temperature at initial pump, bacterial presence with a focus on E. coli, copper, nitrates, phosphorus, sulfates, zinc, arsenic, and manganese. Data collection is just beginning, but patterns in the distribution of groundwater-quality issues are starting to emerge.

AN ASSESSMENT OF USDA CORN CONDITION RATINGS ACROSS THE U.S. CORN BELT

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Changes in temperature, precipitation, and adverse weather across the U.S. Corn Belt associated with anthropogenic climate change may have an effect on corn (Zea mays L.) condition ratings in one of the leading corn production regions in the world. Using USDA National Agricultural Statistics Service data, this study aims to quantify the correlation of corn condition ratings with climate variables and yield, understand intergrowing season behavior of corn condition ratings, and quantify spatiotemporal trends of ratings across the U.S. Midwest (1986–2020). With an existing statistically significant (95% confidence level) correlation between corn condition ratings, Palmer drought indices, precipitation, temperature, and detrended corn yield, it is validated that qualitive rating data should be further examined. Using the Crop Condition Index (CCI), corn condition ratings supportive of positive yield prospects subtly decrease from June to September on average. The CCI values increased within June (ranging from 0.08 to 0.40 CCI yr^{-1}), but subtly decreased within July and onward throughout the Midwest (ranging from –0.02 to –0.62 CCI yr^{-1} over the past 35 yr. From an interannual perspective, corn condition ratings supportive of extreme degrees of yield loss have significantly increased in 7 of the 12 Midwest states (ranging from 0.15 to 0.30% yr^{-1}). Thus, increasing yields despite decreases in corn condition ratings suggests crop advancements such as hybrids and management have offset environment challenges with corn quality. These advancements need to be a continuing effort under a changing climate given rating trends, and corn condition ratings can provide essential risk assessment information for corn producers and other stakeholders.

OIL POTENTIAL IN WESTERN NEBRASKA

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The Denver-Julesburg Basin has produced oil from several reservoirs, predominantly in Cretaceous-age stratigraphic units. The basin extends throughout eastern Colorado, southeastern Wyoming, and into the panhandle of Nebraska. Although western Nebraska has not been as heavily drilled as regions farther south, several productive fields are found there; six southern Panhandle counties produced about 60 million barrels of crude oil in the period 1984-2020. The Dakota sandstone is a prominent stratigraphic unit that is well known for producing oil throughout the Denver-Julesburg basin. The purpose of this research is to explore structural and stratigraphic patterns in the basin. The main target unit of this research is the “J” sandstone. Data from public databases were used to create isopach and surface configuration maps. Maps of the Adena oil field in Colorado, one of the most important “J” sandstone fields, were compared with explored areas of the southern Panhandle. Patterns in the three-dimensional configuration of the “J” sandstone in Kimball County, Nebraska, indicate similarity with the Adena field. The only way to verify the presence of petroleum in this area is by more drilling.

FINALIZING NEW GRAVITY BASE STATIONS ON THE UNL CITY CAMPUS

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Absolute gravity base stations are essential for geophysical surveying that utilize relative gravimeters. The four nearest base stations to UNL campus are the KLNK marker, and the Omaha, Hastings, and Geneva stations. The KLNK marker and the Omaha station are both difficult to access since they are located on the Lincoln airport tarmac and inside the Offutt Air Force Base respectively. They are difficult to access at best and impossible at worst. Both Hastings and Geneva stations are inside public buildings thus are easy to access, but they are both over an hour away from Bessey Hall on UNL Campus. The Sioux Falls CA station is considered a great station due to its low error but is over 3.5 hours away. Between the inaccessibility and distance of these four stations, establishing a gravity base station on UNL Campus for regular use by the UNL Geophysics Team and geophysics classes is necessary.

Two inside and two outside potential base station locations were initially identified. The inside locations were eliminated shortly after the Covid-19 pandemic began due to a lack of accessibility. The two remaining locations are in front of the Mueller (Bell) Tower and in front of the UNL State Museum. Regular measurements were taken at the Tower (68) and the Museum (69) between October 2019 and November 2021. Two drift corrections and a mathematical correction to account for a residual pattern were applied to the readings. Absolute gravity values were transferred to the Tower and Museum after five trips to Hastings and Geneva, one trip to the KLNK marker, and two trips to the Sioux Falls CA base station. There were several options for finalizing the gravity values including averaging, averaging with different weights assigned, and leaving out some of the stations. The final calculation assigned the following weights based on confidence of the station and readings taken there: KLNK marker 40%, Hastings 0%, Geneva 0%, Sioux Falls 60%. The gravity value for the Tower is 980177.760 ± 0.082 mGal and the value for the Museum is 980178.035 ± 0.096 mGal. Thanks to the generosity of NOAA, we established both the Tower and Museum stations on UNL's Campus.

SUMMARIZING SCIENTIFIC DRILLING RESULTS OVER CASCADIA SUBDUCTION ZONE

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The Cascadia Subduction Zone is an active plate margin located off the coast of North America from Northern California to Washington. The margin is formed by the Juan de Fuca plate subducting beneath the North American plate, which has led to elevated seismicity in the area resulting in various hazards such as tsunami and landslides. It is important to assess the potential effects that geologic activity could have on the coastal regions. In this project, data collected during multiple scientific drilling expeditions over the Cascadia Subduction Zone have been summarized and compiled into a single database. All data used in this project was acquired from the International Ocean Discovery Program website. The database also included reports for each expedition detailing the various drill sites. Physical properties gathered from the website included bulk density, natural gamma radiation, magnetic susceptibility, and p-wave velocity. For each site, water depth, core depth, amount of core recovered, and age of basement and sedimentary rocks were documented. A map showing all expeditions for the area was composed. Summarizing results of scientific drilling will supplement two previously developed databases of seismic reflection and refraction data in the Cascadia Subduction Zone, which will help integrate various geophysical data for tectonic mapping and geologic modeling of the area.

PROCESSING SEISMIC, GRAVITY AND MAGNETIC DATA OVER DIEBOLD KNOLL ON JUAN DE FUCA PLATE

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The Diebold Knoll is a submerged seamount on the Juan de Fuca plate with approximately 750m relief from the surrounding seafloor. The location of this seamount away from an active plate boundary and known magma source begs the question of its origin. Besides determining age and tectonic history, investigating the physical properties of this seamount (i.e., density and magnetic susceptibility) will provide helpful parameters for future models of the overall subduction process. The overarching objective of this research is to understand when and why the Diebold Knoll formed and how its formation changed the oceanic crust of the Juan de Fuca plate.

In this study, multiple geophysical datasets including seismic lines, gravity, and magnetic anomalies will be processed and prepared for analysis. Two 2D seismic reflection profiles will be processed, migrated, and then interpreted for subsurface structures. Magnetic data will be used to determine potential age ranges for the formation of the Diebold Knoll and gravity anomaly data to develop crustal model of the seamount and its surroundings. Seismic lines will provide structural framework for gravity and magnetic modeling and well data from ocean drilling projects will be utilized as constraints. The integration of different geophysical methods will help to reveal the origin and evolution of the Diebold seamount.

INTERPRETING THE MANTLE SOURCE OF CENOZOIC BASALTS FROM SOUTH-CENTRAL VIETNAM USING RADIOGENIC ISOTOPES

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Widespread mafic volcanism initiated onshore Vietnam ~17 Ma, with the majority having taken place within ~5 Ma. Most volcanic centers record two eruptive phases: an initial phase of voluminous tholeiitic lava flows followed by less extensive alkali basalts. The heterogeneous geochemical and radiogenic isotope ratios in these lavas are complex and difficult to explain, requiring relatively involved and detailed models for melt generation. To help understand the complex geochemical and radiogenic isotope signatures measured from mafic whole-rocks we contribute new isotopic measurements for a suite of basalts from South-Central Vietnam, including new $^{176}Hf/^{177}Hf$ results. Basalts from our study are primarily tholeiites with unradiogenic to moderately radiogenic $^{143}Nd/^{144}Nd$ and $^{176}Hf/^{177}Hf$ and radiogenic $^{87}Sr/^{86}Sr$, indicating moderate long-term enrichment in incompatible elements in the partial melt source. All samples are also enriched in large ion lithophile elements relative to high field strength elements (e.g., Ba/Nb, Rb/Nb, and Th/Ta), together suggesting a possible lithospheric mantle origin that was formerly metasomatized by subduction-derived fluids. Basalts from this study are also relatively evolved, with moderately high SiO_2 wt.% (45-53) and relatively low Mg# (0.56-0.61).

COMPARING SATELLITE VS MARINE POTENTIAL FIELDS DATA OVER THE BATHYMETRISTS SEAMOUNTS

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The Bathymetrists Seamounts (BSM) are located north of the Sierra Leone Rise (SLR) in the mid-Atlantic Ocean. The seamounts reside on oceanic crust that is 105 to 45 million years old. However, dredging over the Bathymetrists Seamounts dated rocks at ~40 Myr. The general trend of the seamounts contradicts the eastward motion of the African tectonic plate. The origin and tectonic history of the Bathymetrists Seamounts remain debated in the literature. Potential fields (gravity and magnetic) data can provide important insight into the formation and evolution of the seamounts. The purpose of this study is to compare available gravity and magnetic data acquired by two different methods, satellite and marine. Satellite gravity and magnetic data over the Bathymetrists Seamounts and Sierra Leone Rise are publicly available for analysis. However, this data has a relatively low resolution. In contrast, recently acquired marine data from the University of Hamburg are of higher resolution, but are limited to a number of 2-D profiles. Comparing satellite and marine data revealed that each dataset provides advantages and disadvantages for geological analysis. Marine data are useful for 2-D modeling, while satellite data are better for spatial analysis. Combining both data sets will be beneficial for investigating the origin and history of the Bathymetrists Seamounts.

OVERVIEW OF COMPLEX TECTONICS OF THE NORTHERN ATLANTIC

Irina Filina[1], ifilina2@unl.edu 1 - Department of Earth and Atmospheric Sciences, University of Nebraska-Lincoln, Lincoln, NE-68588

Northern Atlantic is an intriguing tectonic region with a variety of unique geologic features such as the hotspot under Iceland, volcanic-rich passive continental margins of Norway and eastern Greenland, as well as active and abandoned spreading centers in the Atlantic Ocean with several pronounced transform zones. The tectonic story of the region is still being re-developed with a recently proposed new continent Icelandia that is being highly debated in the literature. The thick piles of volcanic material on both Norwegian and the eastern Greenland margins prevent confident interpretation of tectonic domains, such as mapping the continent-ocean boundary. The anomalies in potential fields (gravity and magnetic) may be utilized to delineate various tectonic regions, although their interpretation is also inheritably non-unique.

This abstract aims to (1) summarize major tectonic elements of the Northern Atlantic and their expression in various geophysical datasets, namely in seismic and potential fields, (2) compare these geophysical signatures with other regions, and (3) discuss how the uncertainty in geophysical data affect geological interpretations. With the uncertainty of the crustal affiliation of Iceland and the uncertain tectonic domains on the Norwegian and Greenland margins, the tectonic reconstruction of the region remains poorly constrained.

ANALYZING THE CRUSTAL NATURE OF THE VØRING PLATEAU FROM SEISMIC REFRACTION DATA

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The Vøring Plateau is a bathymetric high located off the western continental margin of Norway. The crust of the Vøring Plateau is anomalously thick and includes a high seismic velocity layer at its base. The nature of the crust of the outer plateau is currently being debated. One interpretation suggests that it is oceanic crust that has been thickened by magmatic underplating. An alternative interpretation is that it is continental crust that has been stretched by the rifting of Laurasia and intruded by igneous rocks. To investigate the possibility that the outer plateau is stretched continental crust rather than thickened oceanic crust, seismic refraction data from the 2003 Euromargins survey will be analyzed. The seismic velocity of each refracting layer will be derived from this data using the open source seismic interpretation software OpendTect. A crustal velocity model will then be developed with the free seismic refraction software Refract. Ultimately, the range of possible interpretations allowed by the data will be explored in order to determine if the data is consistent with a stretched continental crust model. The overall purpose of this project is to test alternative geological scenarios to determine which one better agrees with the data. Future work on this project will incorporate gravity and magnetic data to build a more robust crustal model.

ENVIRONMENTAL SCIENCES SECTION Chairperson: **Mark Hammer**

FRIDAY, APRIL 22 **Location: Room 207 Acklie Hall**

If you need assistance connecting via Zoom, or finding the right session, please contact UNL's CSMCE Home Room Support team

11:00-12:00 **MAIBEN LECTURE Olin Hall Lecture Hall 'B'**
https://unl.zoom.us/j/9289316099

Dan Sitzman, Lecture Title: *History of the Nebraska Academy of Sciences*

12:00-12:30 **BUSINESS MEETING Olin Hall Lecture Hall 'B'**
https://unl.zoom.us/j/9289316099
Nebraska Academy of Sciences (all members)
State of the Academy
Awards Ceremony
Comments from Members-at-Large

12:30 – 1:30 **LUNCH** Student Center Cafeteria (pre-purchase ticket or pay-at-door)

1:00 – 1:20 ***NAS Future Leaders Panel*** in the **Sunflower Room** (Student Center by the Cafeteria)
join the informal discussion to learn how you can help lead NAS into the future

AFTERNOON SESSION - 3 **Location: Room 207 Acklie Hall**

1:15 Presenters upload talks from USB drives onto the room computer desktop

1:25 ZOOM Session is open for participants to join https://wsc.zoom.us/j/94970666608

If you need assistance connecting via Zoom, or finding the right session, please contact UNL's CSMCE Home Room Support team

1:30 MAXIMIZING THE SURVIVAL RATE OF MEDITERRANEAN PESTS *SPODOPTERA LITTORALIS* AND *SPODOPTERA EXIGUA* THROUGH EGG STERILIZATION. Delia Muñoz and Sophie Mosher (abstract)

1:45 UNDERSTANDING *DAPHNIA MAGNA* GENOTYPE TOLERANCE DIFFERENCES TO TOXIC BLOOMING ALGAE *MICROCYSTIS*. Kevin Rice, Reilly Cooper and Clay Cressler (abstract)

2:00 ASSESSING ESTROGEN EXPOSURE RISKS IN THE MIDWEST. Nina Patel (abstract)

2:15 Travel to Poster Session, **Location: Smith-Curtis Hall, main level**

POSTER SESSION

ENV-1 NEBRASKA CONVENTIONAL FARMERS' PERSPECTIVES TOWARD AGRICULTURAL HEMP. Nick Gray, Blake Colclasure and Laura Young (abstract)

ENV-2 VOICES FROM GRADUATE SCHOOL AND THE WORKFORCE: IDENTIFIED STUDENT OUTCOMES FROM COMPLETING A MULTI-SEMESTER UNDERGRADUATE RESEARCH EXPERIENCE. Kristina Quinn, Arian Alai and Blake Colclasure (abstract)

ENV-3 UTILIZING BIODIVERSITY PARAMETERS TO ASSESS CORPORATE EFFORTS. Maddy Vasquez (abstract)

5:00 – 7:00 **SOCIAL EVENT** at **LUX Center for the Arts**
Meet with colleagues, make connections, socialize; snacks and soft-drinks, and a cash-donation bar 2601 N. 48th Street, two blocks away
https://www.luxcenter.org/

MAXIMIZING THE SURVIVAL RATE OF MEDITERRAEAN PESTS *SPODOPTERA LITTORALIS* AND *SPODOPTERA EXIGUA* THROUGH EGG STERILIZATION

Delia Muñoz[1], Sophie Mosher[2], smosher@nebrwesleyan.edu
1 - Department of Agronomy, Biotechnology, and Nutrition, Public University of Navarra, Pamplona, Spain;
2 – Department of Biology, Nebraska Wesleyan University, Lincoln, NE.

The Insect lab of the Public University of Navarra's agrobiotechnology institute focuses on using a *Spodoptera*-specific baculovirus to develop a bioinsecticide: a more environmentally-friendly alternative to pesticides, for the moths *Spodoptera exigua* and *Spodoptera littoralis*, two common pests of crops both in the Mediterranean, including Spain, and worldwide. The high death rate of these larvae due to disease makes it difficult for the lab to maintain the vast supply of these moths needed for continued research as many die before they are utilized. A method that increases larval survival rate would allow funds to be devoted to the more central baculovirus research instead of to hatching large numbers of eggs which are not likely to survive. For this reason, a project to increase the percentage of surviving moth larvae in the lab stock was designed and executed. A series of experiments were conducted, all of which used bleach to sterilize the eggs, but differed in apparatuses used, container humidity, and time exposed to bleach, as well as other factors. After sterilization, the eggs were hatched in petri dishes and raised until they became pupae, at which point the final survival rate was determined. No method that significantly increased survival was found, but the data discovered through these experiments is currently being used in further research.

UNDERSTANDING *DAPHNIA MAGNA* GENOTYPE TOLERANCE DIFFERENCES TO TOXIC BLOOMING ALGAE *MICROCYSTIS*

Kevin Rice, Reilly Cooper, Clay Cressler, kevin.rice@huskers.unl.edu
Department of Ecology and Evolution, University of Nebraska-Lincoln, Lincoln, NE.

Daphnia magna are small, freshwater crustaceans common to many North American lakes. A keystone species, they are essential to the trophic function of these lakes as the primary grazers of algae and food for larger predators. Toxic algal blooms can be devastating to populations of *D. magna*, which can lead to larger population reductions in freshwater ecosystems. One such blooming algae is *Microcystis,* a cyanobacteria that has caused numerous large surface blooms in freshwater systems, including the great lakes. The purpose of this study is to determine how different genotypes of *D. magna* respond to ingestion of *Microcystis* and to compare transcript-level differences in genotypes with high survival rates vs. ones with low survival rates. To address this, we exposed 11 different genotypes to *Microcystis* over a period of two weeks, measuring survival rate, fecundity and size to determine tolerance. We found different genotypes had very different responses to exposure, with significant differences in all three variables tested. Two genotypes were selected to be sent off for sequencing: one with high tolerance (8A) and one with low tolerance (K2B) to elucidate if transcript-level differences accounted for contrast in *Microcystis* tolerance. Our current findings indicate certain *D. magna* genotypes might be more suitable for lakes with high propensity for toxic algal blooms. Additionally, after trimming and filtering the transcriptomes, we expect to see differences in gene expression between the two genotypes to explain these tolerance differences.

ASSESSING ESTROGEN EXPOSURE RISKS IN THE MIDWEST

Nina Patel, nrpatel@my365.bellevue.edu
College of Science and Technology, University of Bellevue, Bellevue, NE.

Rising estrogen concentrations have become an emerging health concern. High estrogen levels can cause irregular periods, weight gain, fatigue, fibroids, breast cancer, ovarian cancer, endometrial cancer, and infertility in humans. One potential source of estrogen exposure is surrounding lakes. Lakes located around different populations, such as rural versus urban areas, may have concentrations of estrogen and therefore may pose varying risks to surrounding communities. Estrogen concentrations were assessed at ten Midwestern lakes using High Performance Liquid Chromatography to determine if certain populations were more susceptible to estrogen exposure. I demonstrated that the concentrations of estrogen in rural versus urban areas showed no significant difference, however, I also identified singular lakes that had high estrogen concentrations and could therefore pose a risk to the surrounding community.

NEBRASKA CONVENTIONAL FARMERS' PERSPECTIVES TOWARD AGRICULTURAL HEMP

Nick Gray[1], Blake Colclasure[2], Laura Young[3], blake.colclasure@doane.edu
1 - Undergraduate Student, Doane University, Crete, NE;
2 - Department of Natural Resources & Environmental Sciences, Doane University, Crete, NE;
3 - Department of Agricultural Leadership, Education & Communication, University of Nebraska-Lincoln, Lincoln, NE.

The state of Nebraska legalized hemp cultivation in 2019 and in 2020 a total of 84 licensed farmers made the decision to grow the crop. The state report indicated that there were significant challenges for farmers as they navigated the new crop and regulatory process. Despite these challenges, advocates of hemp cultivation point to the positive environmental and economic implications of hemp as a crop in the Midwest. Hemp has the capacity to increase crop diversity, remove soil toxins, reduce soil erosion, add organic matter to the soil, and serve as a carbon sink. Furthermore, many hemp products are characterized as being eco-friendly and sustainable. Farmers' future hemp adoption, and the speed in which adoption will occur, will be impacted by farmers' knowledge and perceptions toward the newly legal crop. The purpose of this research was to explore Nebraska conventional farmers' perceptions toward hemp cultivation. We focused on three overarching research questions: 1) How do conventional farmers perceive hemp in relation to the characteristics of innovations?; 2) What advantages and disadvantages do conventional farmers identify toward hemp cultivation?; and, 3) What attitudes and behavioral intentions do conventional farmers hold toward incorporating hemp in their future agricultural operations? Convenience sampling was used to recruit seven conventional farmers (six males and one female) in Nebraska who were not growing hemp in the 2020 season. A series of one-on-one interviews using a semi-structured interview guide were conducted to obtain data related to our research questions. Member checking was used to improve the accuracy and completeness of the information and to account for credibility. Interviews were later transcribed and coded via a codebook established prior to the interviews. Using deductive coding methods, two coders worked together to simultaneously code all transcripts. The two coders then worked together to analyze and discuss coded data to identify emerging themes. Results are presented in four themes: 1) Limited Exposure; 2) Technical Challenges; 3) Opportunities; and 4) Impartial Feelings. Our findings indicate that our participants had limited knowledge about hemp cultivation. Some farmers held misconceptions about hemp and associated it with marijuana. None-the-less, farmers believed there to be opportunities and benefits toward growing hemp, but the technical challenges outweighed those benefits, leaving farmers to believe they would never grow hemp themselves. Interestingly, farmers were impartial if others grew hemp. We recommend creating educational programs for conventional farmers to learn about and observe hemp cultivation to increase hemp adoption.

VOICES FROM GRADUATE SCHOOL AND THE WORKFORCE: IDENTIFIED STUDENT OUTCOMES FROM COMPLETING A MULTI-SEMESTER UNDERGRADUATE RESEARCH EXPERIENCE

Kristina Quinn[1], Arian Alai[1], Blake Colclasure[2], kristina.quinn@doane.edu
1 - Undergraduate Student, Doane University, Crete, NE;
2 - Department of Natural Resources & Environmental Sciences, Doane University, Crete, NE.

A need exists for advancements in undergraduate science education that challenges students to replicate the process of scientific inquiry and problem solving in authentic settings. Undergraduate Research Experiences (UREs) offer undergraduates the opportunity to participate in research-based projects through faculty mentorship. Although there are many types and structures of UREs, most extensive URE programs are supplemental to degree requirements. At Doane University, a Primarily Undergraduate Institution (PUI), all undergraduate students majoring in biology, chemistry, or environmental science complete a three-semester URE that serves as a required capstone for degree completion. Students select a faculty mentor and work with them to design, conduct, analyze, and disseminate a scientific research project of original scope and of high scientific rigor related to the student's major. The purpose of our study was to explore the impact of this URE through the lens of the student experience. We specifically examined the outcomes of the URE and the impact it had on students' post-baccalaureate success in their career or graduate education. A hermeneutic phenomenological approach was used to identify recent graduates' perceptions toward their URE capstone at Doane. A sampling frame of graduates who completed an undergraduate degree in biology, chemistry, or environmental science in 2016 through 2020 was established and each individual was sent an invitation to participate in the research. Sixteen graduates who were either enrolled in graduate school or who were in a career related to their undergraduate major agreed to participate. A semi-structured interview guide was used to facilitate one-on-one interviews with each participant. Each interview lasted approximately one hour and each interview was transcribed. Three researchers worked together to create a codebook containing emergent codes from the transcriptions. After the codebook was finalized, two researchers used MAXQDA software to independently code 20% of the transcriptions to establish intercoder reliability using Krippendorf's alpha. After several iterations, intercoder reliability was deemed reliable at .82. The remaining transcriptions were split between the two researchers to complete coding. Codes were condensed and reorganized to create emergent themes related to our research questions. Results of the research include three themes: 1) Soft Skill Acquisition and Future Application; 2) Technical Skill Acquisition and Future Application; and 3) Development of Interest and Self-Efficacy in Conducting Authentic, Scientific Research. The results of this study demonstrate that UREs can be extremely beneficial to students' success in STEM careers and graduate school. This research was approved by the Doane University IRB.

UTILIZING BIODIVERSITY PARAMETERS TO ASSESS CORPORATE EFFORTS

Maddy Vasquez, maddy.vasquez2000@gmail.com

Department of Science and Technology, University of Bellevue, Bellevue, NE.

Many habitats provide valuable ecosystem services such as habitat, pest control, and wastewater treatment. Some of these habitats are considered undesirable due to their aesthetic features. One of Omaha Public Power District's recent projects, Prairie in Progress, has aimed to enhance ecosystem services in areas that were previously considered unusable, such as areas surrounding power facilities. Increasing species diversity is one method to enhance ecosystem services. The primary focus of this project is to assess Omaha Public Power District's goal of enhancing ecosystem services by assessing changes in species diversity using the Simpson Diversity Index.

PHYSICS SECTION Chairperson: **Adam Davis**

FRIDAY, APRIL 22 **Location: Room 007 Acklie**

MORNING SESSION - 1

7:30 a.m. Presenters upload talks from USB drives onto the room computer desktop.

7:45 ZOOM Session opens for participants to join: https://wsc.zoom.us/j/94755958894

If you need assistance connecting via Zoom, or finding the right session, please contact UNL's CSMCE Home Room Support team

8:00 VISUALIZING INTERFERENCE IN AN ACOUSTIC DOUBLE SLIT EXPERIMENT. Alexis Hobelman, John Kunkee, Xander Schmit, Owen Root, and Maria Becker (abstract)

8:15 MEASURING AND DISPLAYING INTERFERENCE IN AN ACOUSTIC DOUBLE-SLIT EXPERIMENT. John Kunkee, Xander Schmit, Alexis Hobelman, Owen Root, and Maria Becker (abstract)

8:30 EXPLORING QUANTUM COMPUTATION AND ENTANGLED TWO-QUBIT SYSTEMS. Xander Schmit and Maria Becker (abstract)

8:45 ACOUSTIC DOUBLE-SLIT EXPERIMENT - PHASE-SHIFTING CIRCUIT. Owen Root, Alexis Hobelman, John Kunkee, Xander Schmidt, Vanessa Wergin, and Maria Becker (abstract)

9:00 COMPUTATIONAL MODELLING OF IMPEDANCE BASED CELL MIGRATION FOR RADIOTHERAPY AGAINST BRAIN METASTASIS. Bayode Ibironke, Melanie Schwengler, Katherine Lemke, Andrew Ekpenyong (abstract)

9:15 COMPUTATIONAL MODELING OF IMPEDANCE BASED CELL MIGRATION FOR INCREASED CHEMOTHERAPY AND RADIOTHERAPY. Melanie Schwengler, Katherine Lemke, Bayode Ibironke, Andrew Ekpenyong (abstract)

9:30 **BREAK**
Presenters upload talks from USB drives onto the room computer desktop.

MORNING SESSION - 2 https://wsc.zoom.us/j/94755958894

9:45 ANALYZING BROAD ABSORPTION LINE QUASARS WITH PYTHON. Jack Pereira (abstract)

10:00 REMOTE CONTROLS FOR PARTICLE COLLISION DETECTORS. Colin Recker (abstract)

10:15 SLOW CONTROLS SOFTWARE DESIGN FOR BEACON 410A GAS MONITORS FOR THE STAR sTGC. Rebecca Powers (abstract)

10:30 SIMULATING ULTRA-PERIPHERAL COLLISIONS WITH STARLIGHT. Hephzibah Akinleye and Janet Seger (abstract)

11:00-12:00 **MAIBEN LECTURE** **Olin Hall Lecture Hall 'B'**
https://unl.zoom.us/j/9289316099

Dan Sitzman, Lecture Title: *History of the Nebraska Academy of Sciences*

12:00-12:30 **BUSINESS MEETING** **Olin Hall Lecture Hall 'B'**
https://unl.zoom.us/j/9289316099
Nebraska Academy of Sciences (all members)
State of the Academy
Awards Ceremony
Comments from Members-at-Large

12:30 – 1:30 **LUNCH** Student Center Cafeteria (pre-purchase ticket or pay-at-door)

1:00 – 1:20 ***NAS Future Leaders Panel*** in the **Sunflower Room** (Student Center by the Cafeteria) join the informal discussion to learn how you can help lead NAS into the future

AFTERNOON SESSION - 3

1:15 p.m presenters upload talks from USB drives onto the room computer desktop

1:25 ZOOM Session is open for participants to join: https://wsc.zoom.us/j/94755958894

1:30 MAGNETIC BRAKING SYSTEM. Trevor Adelung (abstract)

1:45 ATTRACT AND REPEL WITH ELECTROMAGNETIC GLOVE. TyDus Clay (abstract)

2:00 FORCES IN FOOTBALL. Dayris Bonillas (abstract)

2:15 UNDERSTANDING THE THIELE-SMALL PARAMETERS THROUGH THE DESIGN OF A HOME-BUILT LOUDSPEAKER. Wren Allen (abstract)

2:30 BREAK
Presenters upload talks from USB drives onto the room computer desktop if not done already

AFTERNOON SESSION - 4

2:40 ZOOM Session is open for participants to join: https://wsc.zoom.us/j/94755958894

2:45 CONSTRUCTING A SUPERCONDUCTIVE RACE TRACK. Skylar Balent (abstract)

3:00 WIRELESS POWER TRANSMISSION: DESIGNING A NEAR-FIELD SYSTEM AND CURRENT CHALLENGES WITH FAR-FIELD. Keaton Ludwig (abstract)

3:15 HYDRO-ELECTRIC POWER SYSTEM. Mason McMeen (abstract)

3:30 (IN)FEASIBILITY OF THE PARTICLE MODELS OF THE CASIMIR EFFECT. Evan Fulton and Herman Batelaan (abstract)

5:00 – 7:00 **SOCIAL EVENT** at **LUX Center for the Arts**
Meet with colleagues, make connections, socialize; snacks and soft-drinks, and a cash-donation bar 2601 N. 48th Street, two blocks away https://www.luxcenter.org/

VISUALIZING INTERFERENCE IN AN ACOUSTIC DOUBLE SLIT EXPERIMENT

Alexis Hobelman, John Kunkee, Xander Schmit, Owen Root, and Maria Becker,
ahobelma@nebrwesleyan.edu
Department of Physics, Nebraska Wesleyan University, Lincoln, NE

When introducing students to quantum mechanical concepts, it is often helpful to draw comparisons with classical phenomena to which the student has already been exposed. Using acoustic waves in place of electrons in a double-slit experiment demonstrates the connections between these two concepts. Student understanding is further benefitted through the use of visual representations. Here we provide two visual representations; one displays the time-averaged intensity of interfering sound waves detected by a microphone on an LED light strip, and another animates wave propagation and interference patterns using Python and Matplotlib animation tools. The development of these visual representations will be discussed in detail. Both are expected to help to increase student understanding by providing tangible demonstration of an invisible process.
This work is supported by a Nebraska EPSCoR FIRST Award (grant no. OIA-1557417).

MEASURING AND DISPLAYING INTERFERENCE IN AN ACOUSTIC DOUBLE-SLIT EXPERIMENT

John Kunkee, Xander Schmit, Alexis Hobelman, Owen Root, and Maria Becker, jkunkee@nebrwesleyan.edu
Department of Physics, Nebraska Wesleyan University, Lincoln, NE

The Acoustic Double Slit project emulates the quantum double-slit experiment by creating an analog to the quantum time-dependent interference pattern. The interference pattern created using two 40 kHz speakers is captured by mounting a microphone on a translation stage and measuring the pattern relative to position. The time-averaged interference pattern is recorded via a voltage rectifier circuit and fed into an Arduino to be displayed on an LED strip. The design and implementation of the voltage rectifier circuit will be discussed as well as the code to control the translation stage. This work is supported by the Nebraska EPSCoR program (grant no. OIA-1557417).

EXPLORING QUANTUM COMPUTATION AND ENTANGLED TWO-QUBIT SYSTEMS

Xander Schmit and Maria Becker, xschmit@nebrwesleyan.edu
Department of Physics, Nebraska Wesleyan, University, Lincoln, NE.

The quantum process of decoherence limits the scalability of quantum computers. In this study, we are investigating entanglement, a precursor to decoherence, and a purely quantum mechanical phenomenon. We are working towards the development of a custom quantum gate that will create a two-qubit system that oscillates between being fully entangled and being in a separable state (not entangled at all). Working towards this goal has involved learning the basics of quantum computation and quantum information science. Experiments performed on IBM Quantum Computers allow us to test our theoretical predictions. This talk will introduce quantum computation, entanglement, and performing experiments on the IBM Q. The status of our current work involving a custom quantum gate will also be discussed. This work is supported by a Nebraska EPSCoR FIRST Award (grant no. OIA-1557417).

ACOUSTIC DOUBLE-SLIT EXPERIMENT - PHASE-SHIFTING CIRCUIT

Owen Root, Alexis Hobelman, John Kunkee, Xander Schmidt, Vanessa Wergin, and Maria Becker, oroot@nebrwesleyan.edu
Department of Physics, Nebraska Wesleyan, University, Lincoln, NE.

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 wave being sound. We can easily study sound waves and can therefore use them as a model of the wave nature of quantum mechanics. By using an apparatus to create an acoustic double-slit with controls over the phase and timing of the sound waves, it is possible to emulate and explore dephasing and decoherence. These two quantum processes remove 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 overviews previous work done on this project and the ongoing design and construction of a variable phase shifting circuit, an essential element to emulate dephasing and decoherence. This work is supported by a Nebraska EPSCoR FIRST Award (grant no. OIA-1557417).

ANALYZING BROAD ABSORPTION LINE QUASARS WITH PYTHON

Jack Pereira, jackpereira@creighton.edu
Department of Physics, Creighton University, Omaha, NE;

By using python, a code is in the process of being created in order to analyze quasar files from the Sloan Digital Sky Survey (SDSS) database automatically. The flux and wavelength from the file is fitted. If a file has carbon-4 absorption lines, the program will fit the spectra as if there is no absorption line to analyze the absorption line. The wavelength is turned into units of velocity. It calculates the Balnicity Index, which is a way to gauge how much absorption is present, the starting velocity and ending velocity of the absorption. Then, the data is compared with Isabelle Pâris' "The Sloan Digital Sky Survey Quasar Catalog: Twelfth data release" to gain an understanding whether the code is effective.

COMPUTATIONAL MODELLING OF IMPEDANCE BASED CELL MIGRATION FOR RADIOTHERAPY AGAINST BRAIN METASTASIS

Bayode Ibironke, Melanie Schwengler, Katherine Lemke, Andrew Ekpenyong,
bayodeibironke@creighton.edu
Department of Physics, Creighton University, Omaha, NE

The Problem: Cell migration is a major component of malignant tumor progression, especially to the brain. About one-third of patients with another type of cancer will develop one or multiple metastatic brain tumors. The most common origins of brain metastasis are systemic cancer of the lung, breast, skin, or GI tract. In the Translational Biomedical Physics Lab, several nanoparticle-mediated strategies have been developed to improve treatment outcomes for radioresistant cancers of the brain such as glioblastoma. Here, we begin applying those strategies to cancers that have metastasized to the brain.

Experimental and Computational Methods: 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, Fixation), we have applied equivalent circuits and power-law equations to model the complex impedance data, using MATLAB codes. Additionally, R codes were used to model with three different curve fit algorithms: smoothing spline, logistic model, and segmented regression. My role in this project is to adapt the R codes for modelling ECIS results obtained in the case of cancers that metastasize to the brain.

Preliminary Results: Previous results from using MATLAB codes on glioblastoma cells capture the increased migration of irradiated cells prior to cell death. Recently published R codes written for ECIS data appear more robust in fitting experimental data and may also succeed in providing biophysically relevant insights into metastasis. Preliminary results using our adjusted R codes will be presented.

COMPUTATIONAL MODELING OF IMPEDANCE BASED CELL MIGRATION FOR INCREASED CHEMOTHERAPY AND RADIOTHERAPY

Melanie Schwengler, Katherine Lemke, Bayode Ibironke, Andrew Ekpenyong,
mcs69264@creighton.edu
Department of Physics, Creighton University. Omaha, NE

Metastasis describes the process of cancer cells spreading from the primary tumor to other tissues and organs of the body where they form new tumors; this accounts for over 90% of cancer deaths. A crucial step in the metastatic cascade is migration. We have recently quantified the impact of current cancer treatment approaches on cancer cell migration, using bioimpedance as a readout. Here, we present computational fits for experimental data which provides mechanistic insights into the role of various chemotherapeutic and radiotherapeutic approaches on 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, Fixation), we applied equivalent circuits and power-law equations to model impedance data using MATLAB codes. Additionally, R codes were used to model with three different curve fit algorithms: smoothing spline, logistic model, and segmented regression. Without data fitting, we find that the irradiated T98G cells (Glioblastoma, brain cancer cells) attach and migrate significantly more than non-irradiated cells in the first 20 hours post-irradiation. Fits of equivalent circuit models and power-law models quantify and characterize the raw impedance data for brain cancer cells. MATLAB codes capture the increased migration of irradiated cells prior to cell death. In MATLAB, the model parameters such as the power-law exponent capture the increased migration of irradiated cells prior to cell death. In the future, R codes may also succeed in providing robust and biophysically relevant insights into metastasis which, in turn, can potentially inform urgently needed anti-metastasis strategies in cancer treatments.

REMOTE CONTROLS FOR PARTICLE COLLISION DETECTORS

Colin Recker, cgr46735@creighton.edu
Department of Physics, Creighton University, Omaha, NE;

Modern day particle detectors consist of thousands of components that work together to track particles emitted in high-speed particle collisions. Since particle accelerators produce dangerous radiation, the detectors must be controlled remotely. The detector components are interconnected by a local network of computers. These computers monitor and control the components using Input-output control (IOC) programs that create process variables (PVs), for each component. These process variables are accessible on the local network by the Experimental Physics and Industrial Control System (EPICS) software. This network control software enables the control, monitoring, and communication of all detector components across the network. The original EPICS software that controls and monitors these PVs is based in the C coding language. This is an older form of EPICS that is currently being replaced by the Python based pyEPICS. This version of EPICS more user friendly and versatile. I will discuss the general methods of detector control using EPICS. Specifically, I will discuss the revision of the C-based EPICS code that controls the Solenoidal Tracker at RHIC (STAR) detector magnet.

SLOW CONTROLS SOFTWARE DESIGN FOR BEACON 410A GAS MONITORS FOR THE STAR sTGC

Rebecca Powers, rep20853@creighton.edu
Department of Physics, Creighton University, Omaha, NE

The Solenoidal Tracker at RHIC (STAR) is a large detector system used to analyze heavy ion and polarized proton-proton collisions at the Relativistic Heavy Ion Collider (RHIC) at Brookhaven National Laboratory. During RHIC's annual runs, radiation levels are too high during beam operation for in-person monitoring of equipment. For safety, efficiency, and convenience, the subsystems are remotely controlled and monitored using EPICS (Experimental Physics and Industrial Control System). An upgrade to STAR, installed for data-taking in 2022, is the sTGC (small-strip thin gap chamber), a detector used specifically to detect particles in the forward rapidity region. The sTGC includes a gas system with RKI Instruments Beacon 410A Gas Monitors for monitoring the pentane concentration to avoid excess levels of pentane, which would constitute a flammable hazard. This project used SoftIOC, a Python module that allows the creation of EPICS process variables (PVs) for the new Beacon gas monitors. The code defines the various MODBUS_RTU registers for each Beacon device, a variable associated with the device status, and four channels to monitor the gas system. Defined within each channel are the gas status, the measured value, and its units. The code, along with the Beacon gas monitors, has been installed and tested before the beginning of the 2022 run. This poster will outline the methodology and design behind the Beacon gas monitors' process variables and provide insight into the Python code to be implemented.

SIMULATING ULTRA-PERIPHERAL COLLISIONS WITH STARLIGHT

Hephzibah Akinleye and Janet Seger, hba99816@creighton.edu
Department of Physics, Creighton University, Omaha, NE 68178.

One of the pinnacles in science was reached when we learned that mass is just a form of energy and is not separately conserved. Because of this, energy is released when atoms are broken up into smaller fragments in nuclear fission and assembled into larger pieces in nuclear fusion. At the advent of high energy physics, particles with masses far greater than the masses of the initially collided particles were produced in accelerators. These observations were able to provide information about the nature of fundamental interactions and the make-up of several particles. An even more extreme example occurs in relativistic ultra-peripheral collisions of nuclei, where the interacting nuclei pass by each other but do not physically collide. This type of collision creates new particles by transforming the extremely high energy of the interacting ions via the electromagnetic force and is often modeled by the exchange of virtual photons between these ions. The interaction of the virtual photons emitted by one nucleus with the other nucleus in this kind of collision is then used to obtain information about the internal structure of the nuclei. These interactions have been successfully simulated with a few Monte Carlo-based programs. Of all the programs used in simulating ultra-peripheral collisions, STARlight is currently the most popular. I will be presenting the current features of STARlight, the success of the program so far and upcoming features to be implemented.

MAGNETIC BRAKING SYSTEM

Trevor Adelung, trevor.adelung17@hastings.edu
Department of Physics, Hastings College, Hastings, NE.

This project will explore the physics behind magnetic braking to slow a mass on a zipline down to a safe speed for landing. A magnetic brake will be constructed using neodymium magnets and a conductor such as copper. Once constructed, the brake will be tested to demonstrate the effects of magnetic braking. The test will involve slowing a 60-pound sandbag down below 15 miles per hour as the mass approaches the end of the zipline. We then wish to determine the distance needed to apply the braking force, in order to correctly place the braking system. The project will demonstrate the effectiveness and safety of magnetic braking in the use of ziplining, as well as prove that magnetic braking is a reliable and efficient way of applying a braking force for use in other applications.

ATTRACT AND REPEL WITH ELECTROMAGNETIC GLOVE

TyDus Clay, tydus.clay@hastings.edu
Department of Physics, Hastings College, Hastings, NE;

I will be creating an electromagnetic glove that will be able to attract and repel ferromagnetic metals. So, for my project I will need to dive deeper into the physics of electromagnetism. Electromagnetism and magnetic induction is the physics aspect of how I will create my electromagnet glove. Electromagnets are a huge part of people's everyday life being used in headphones, motors and in MRI machines[4]. An electromagnet is a magnet that has an iron core or a core with a high susceptibility, that also has magnetic wire wrapped uniformly around it, in which a current is going around it turning the core into a magnet. The electromagnet has the same properties as a permanent magnet that you have at home on your refrigerator hanging up your best report card, such as a north and South Pole and the ability to attract magnetic objects [3]. The major difference is that an electromagnet can be turned on and off. To put it simply an electromagnet is just wire wound up making a coil that has electricity flowing through it making a magnetic field [3]. The more loops of wire, the stronger the magnetic field, the stronger the magnetic field, the stronger the electromagnet. The magnet I will produce will be able to lift up to one pound of some paramagnetic metal and also lift small metals such as paper clips from a distance. For the small metals I will test the critical distance and voltages for the specific weights of the small objects. I will also add a switch to my circuit to switch the polarization of the current to repel the same metals, which I will calculate the critical distance and voltages as well. So in my presentation I will walk you through the trials and tribulations of creating my electromagnetic glove.

FORCES IN FOOTBALL

Dayris Bonillas, dayris.bonillas17@hastings.edu
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Around 300,000 concussions happen a year due to football. Taking a deeper look into the physics behind football, this project will investigate the forces that are created when two football players come into contact with one another. To execute this project a helmet will be placed on a test dummy and will be hit with different amounts of force resulting in different accelerations. The acceleration will be recorded by an accelerometer that will be mounted on the outside of the helmet. These results will be only based off the acceleration collected from the accelerometer as the force sensors will produce their own separate data from an Arduino board. The sensors will be connected to an Arduino board that will be programmed to instruct a LED to light up when the max amount of acceleration is 90g-force and above which is the range where a concussion can occur. The end goal is to be able to make sure players are safe and not further injuring themselves by not knowing whether they have a concussion or lying about one to stay in the game.

UNDERSTANDING THE THIELE-SMALL PARAMETERS THROUGH THE DESIGN OF A HOME-BUILT LOUDSPEAKER

Wren Allen, wren.allen@hastings.edu
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Over time, innovations in sound systems and speakers have been revolutionized. Many types of speakers have been designed to build the most efficient and best speaker. Loudspeakers have a multitude of physics involved inside them whether that be mechanical physics, electronics, or magnetic fields. We can model the physics of a speaker as a mass on a spring. The diaphragm mass and stiffness provided by the suspension of the spider form a system as such as a mass on a spring. The more complex physics for a loudspeaker design, however, is cultivated from the Thiele-Small parameters. The Thiele-Small parameters can be used to predict the performance of a speaker in different speaker enclosures. By observing the Thiele-Small parameters, one can plot impedance curves which can reveal much about a loudspeaker. One of the characteristics that an impedance curve reveals is the phase of the sound at any particular frequency. This helps select crossover components based on phase as well as resistance. An impedance curve will also show the resonant frequency (f_s) and the DC resistance, measured in Hertz and Ohms respectively. Finally, an impedance curve reveals the impedance, measured in ohms, of the driver of a speaker. In this project, the Thiele-Small Parameters will be observed and measured for a home-built loudspeaker, while also showing how a loudspeaker acts as a system of a mass on a spring. The loudspeaker will be observed in several different cabinet sizes to show the differences in sound quality and impedances.

CONSTRUCTING A SUPERCONDUCTIVE RACE TRACK

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Department of Physics, Hastings College, Hastings, NE.

For my senior project I created a maglev train system that allows me to control the motion of a train car back and forth using superconductivity and electromagnetism. The track is made of neodymium magnets and the sides of the track have electromagnets formed from copper wire, so I can control the magnetic field on the track. Then I poured liquid nitrogen inside the train car(which has a Yttrium barium copper oxide magnet inside it; YBCO for short) to levitate it on the track via the Meissner Effect. On top of the train car I have another neodymium magnet to anchor the train onto the track and pull the train car forward via the electromagnets. The electromagnetic field of the track pushes the train car forward by using an AC current from a waveform function generator; this will cause the magnetic field to switch between the North and South poles on the electromagnets. The train car will be pulled on the stream of pulse “waves”, pushing the train car forward. I will be able to push it backwards by reversing the current using a switch, and stop the train car by turning off the current flowing through the track, returning the magnetic field to a static state.

WIRELESS POWER TRANSMISSION: DESIGNING A NEAR-FIELD SYSTEM AND CURRENT CHALLENGES WITH FAR-FIELD SYSTEMS

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Department of Physics, Hastings College, Hastings, NE

Innovations within the last decade have allowed for the average consumer to experience greater applications of *wireless power transmission* (WPT) in their daily life. Smartphones, watches, and even some electric vehicles feature WPT called *near-field transmission* (NFT) that is widely available to consumers today. Nikola Tesla's invention of Tesla coils introduced NFT technology that has been the foundation for many modern appliances and products today. Tesla coils achieve NFT by a method called *inductive coupling*; the wire coils induce a magnetic field allowing for electrical energy to be resonated to devices within the area of the field. There are, however, multiple methods to achieve NFT including *resonant-inductive coupling* which is the primary focus of this project as most consumer applications utilize this method. The second focus area of this project is applications of *far-field transmission* (FFT). Contrary to NFT, FFT deals with transferring power over larger distances and uses a different technique called *power-beaming/beamforming* which projects electromagnetic radiation in a specific direction allowing it to travel greater distances. As promising as FFT sounds, it has presented researchers with several roadblocks. Issues such as interference, efficiency, and system cost all limit (at least currently) how viable this technology is. This project will showcase the construction of a typical resonant-inductive NFT system and then explain the advantages and current challenges associated with FFT systems.

HYDRO-ELECTRIC POWER SYSTEM

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Department of Physics, Hastings College, Hastings, NE.

In this project I will be applying laws of physics to construct a water wheel that will be used to generate electricity when attached to a common house gutter system. I will be making this system to convert rainwater into electricity. Some of the main laws applied to this design will be the first law that goes into the process of a water wheel construction process is Newton's Laws for Rotation. The next concept that is important is relative motion which will be used to calculate the force on the moving buckets on the water wheel. This combined with Newton's second law will be used to calculate the torque that is on the shaft of the motor. Faraday's law is used to convert the motion of the water wheel into electricity. Along with these Key laws in physics there will also be the calculation of the efficiency of the diagram power, waterpower, and shaft power. With these calculations I will be able to calculate the hydraulic efficiency and mechanical efficiency of the entire system. This will lead to the overall efficiency that will be used to calculate the loss in efficiency in the motor. From here we will be able to measure the efficiency of the water wheel. We will also be able to see the output voltage of the system corresponding to how much power the system can produce given x amount of rainfall.

(IN)FEASABILITY OF DYNAMIC PARTICLE MODELS OF THE CASIMIR EFFECT

Evan Fulton, Herman Batelaan, efulton2@unl.edu
Department of Physics, University of Nebraska-Lincoln, Lincoln, NE

The Casimir effect is conventionally derived by wavemode- or field-based models. The Casimir effect describes net pressures due to quantum vacuum effects and differences in allowed electromagnetic wave-modes in different regions electrically conductive structures, for instance, a discrete set of modes in between or continuous set outside of parallel conducting plates. The magnitude of the force can be calculated either by following potential energy or momentum transfer. We develop a highly general model of virtual photon generation in the vacuum and show that it cannot be simultaneously rectified with the established vacuum spectral energy density and the momentum transfers involved in the Casimir effect. We thereby demonstrate that particle models of the Casimir effect are infeasible, in the sense that any particle model thereof must violate one or more vital principles (e.g., Heisenberg uncertainty, conservation of energy, etc.) or require increasingly *ad hoc* premises.

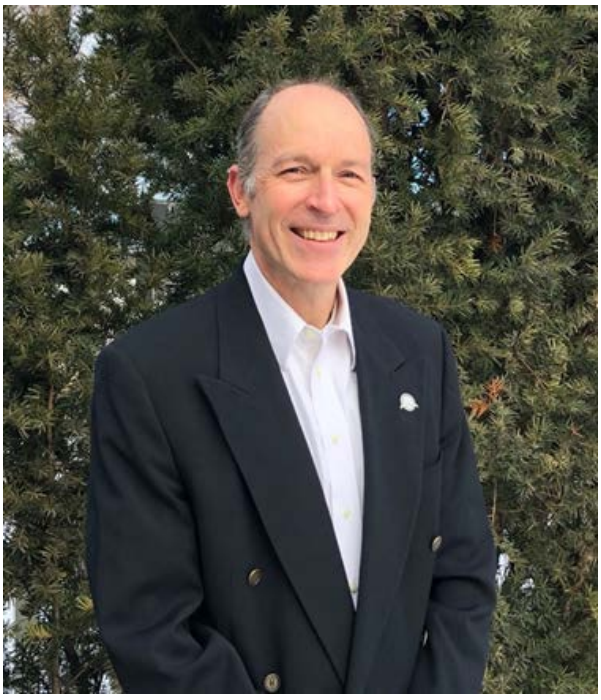
FRIENDS OF THE ACADEMY

The Academy has several endowments courtesy of Benjamin and Rachael Corr Maiben (1959), and C. Bertrand and Marian Othmer Schultz (1992).

Special recognition goes to the University of Nebraska-Lincoln's Center for Science, Mathematics and Computer Education for technological support during the meeting and to Nebraska Wesleyan University for hosting our return to in-person presentations.

2022 Maiben Lecturer:

Dan Sitzman



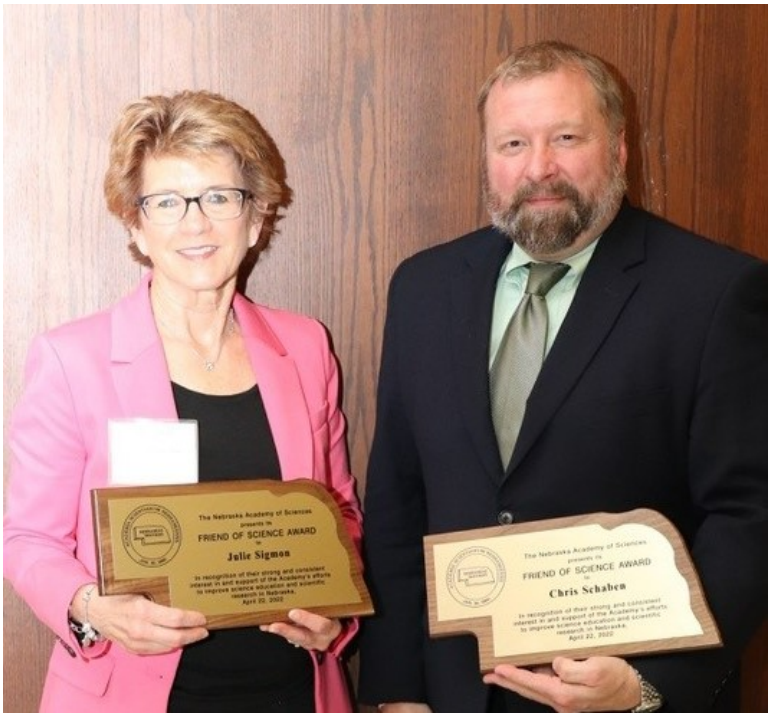
Dan Sitzman is a Omaha Public Schools Science Educator with 31 years experience at middle and high school level. As a biology and chemistry teacher at Omaha North High Magnet School, he received the 2003 Presidential Award for Excellence in Science Teaching. Dan then served as Curriculum Specialist at Omaha North for 12 years, remaining directly involved with students as co-sponsor for the school's Science Olympiad and Science Bowl teams, mentoring Science Fair students and directing Omaha North STEM Summer Camps. Since 2015, Dan has served as a districtwide Science Instructional Coach, supporting science teachers at 12 middle schools and seven high schools. He continues to mentor student science researchers, including many who have presented at the American Junior Academy of Sciences. His professional leadership at the local, state, and national level includes terms as President of the Nebraska Academy of Sciences, Nebraska Association of Teachers of Science, and, currently, the Metropolitan Science and Engineering Fair. He presently serves on boards for Nebraska Science Festival, Nebraska Science Olympiad, Nebraska Junior Academy of Sciences, and on the Long-Range Planning Committee for the Nebraska Academy of Sciences. For over two decades, he has taught at University of Nebraska-Omaha's Aim for the Stars Summer STEM Camps. When he is not bicycling or hiking with his family, Sitzman researches and catalogs the histories of local organizations, including high school sports teams, the Nebraska Association of Teachers of Science, and the Nebraska Academy of Sciences. Dan earned a B.S. in natural science from St. John's University (MN) and an M.S. in curriculum and instruction from University of Nebraska-Omaha.

Maiben Memorial Lecture Overview

The Nebraska Academy of Sciences is one of the oldest academies in the United States, with a history reaching to the early days after statehood. During its 142 years, the Academy membership includes names and discoveries familiar to Nebraskan, as well as people and events that are now cloaked by time. The 2022 Maiben Memorial Lecture will trace the organizational ancestry of the Academy, connecting the present day with those who came before us.

***2022 FRIEND OF SCIENCE AWARD TO*:**

Julie Sigmon and Chris Schaben



Julie Sigmon has experience in the education, non-profit and business fields for over 40 years. She is currently serving as the Director for the Omaha STEM Ecosystem, a backbone organization in support of a collective impact initiative to grow the number of STEM professionals to create a balance between industry demand and available talent. Her previous experiences involved Special Education teacher, school administrator, Chief Operating Officer of a local non-profit youth organization and contract work around quality in STEM programs, specifically Out of School Time programs, as well as serving as the external evaluator for the NE STEM 4U program at University of Nebraska at Omaha. She currently serves on the Board for Clarkson College, Heartland Workforce Solutions Youth Council, NE Beyond School Bells Network, Omaha Chamber Education Advisory Council, Women In STEM/BioNebraska Leadership, Aviation STEM Day, Metro Science and Engineering Fair, NE Science Festival and Member for the Blueprint STEM Ralston School District.

Chris is an effective leader of local and state science and science education organizations. As a past-president of the Nebraska Academy of Sciences, Schaben guided us on the executive board through issues that could have damaged the organization without his skill and willingness to listen to others. He is a AAAS Fellow. He currently serves as Vice-President of the Nebraska Junior Academy of Sciences, supporting and completing the transition of the organization into a 501(c)3 non-profit, expanding the acquisition of resources to support student researchers from rural and urban areas. As an advisor for the educational programming since the inception of the Nebraska Science Festivals, Schaben led a subcommittee that created a children's participation guide that promoted careful observation and thinking about the exhibits to replace a word find and scavenger hunt that had been drafted by others.

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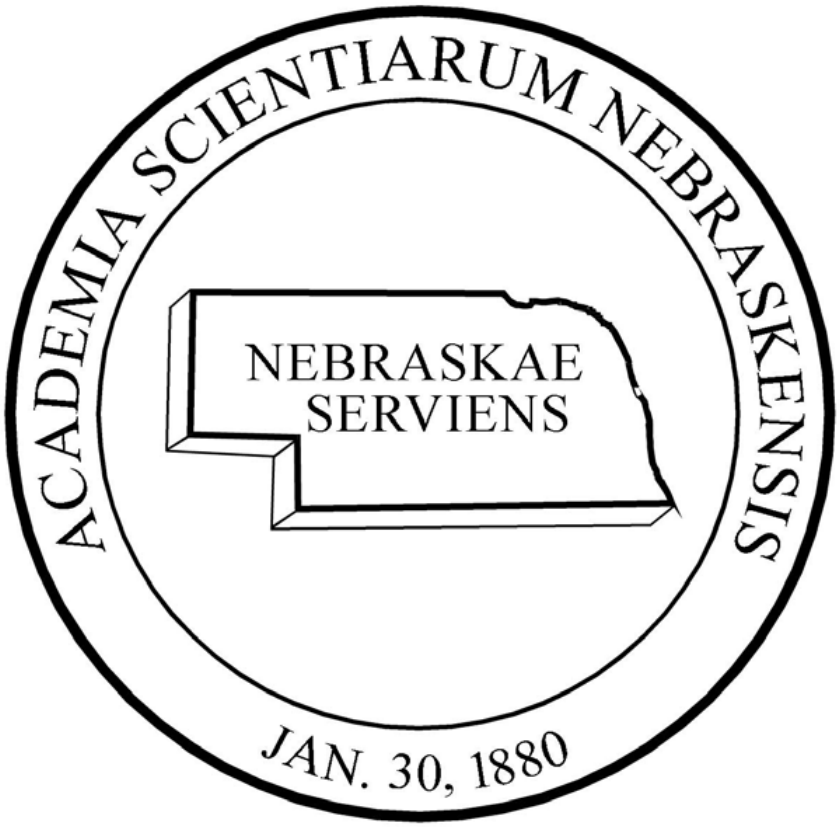
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