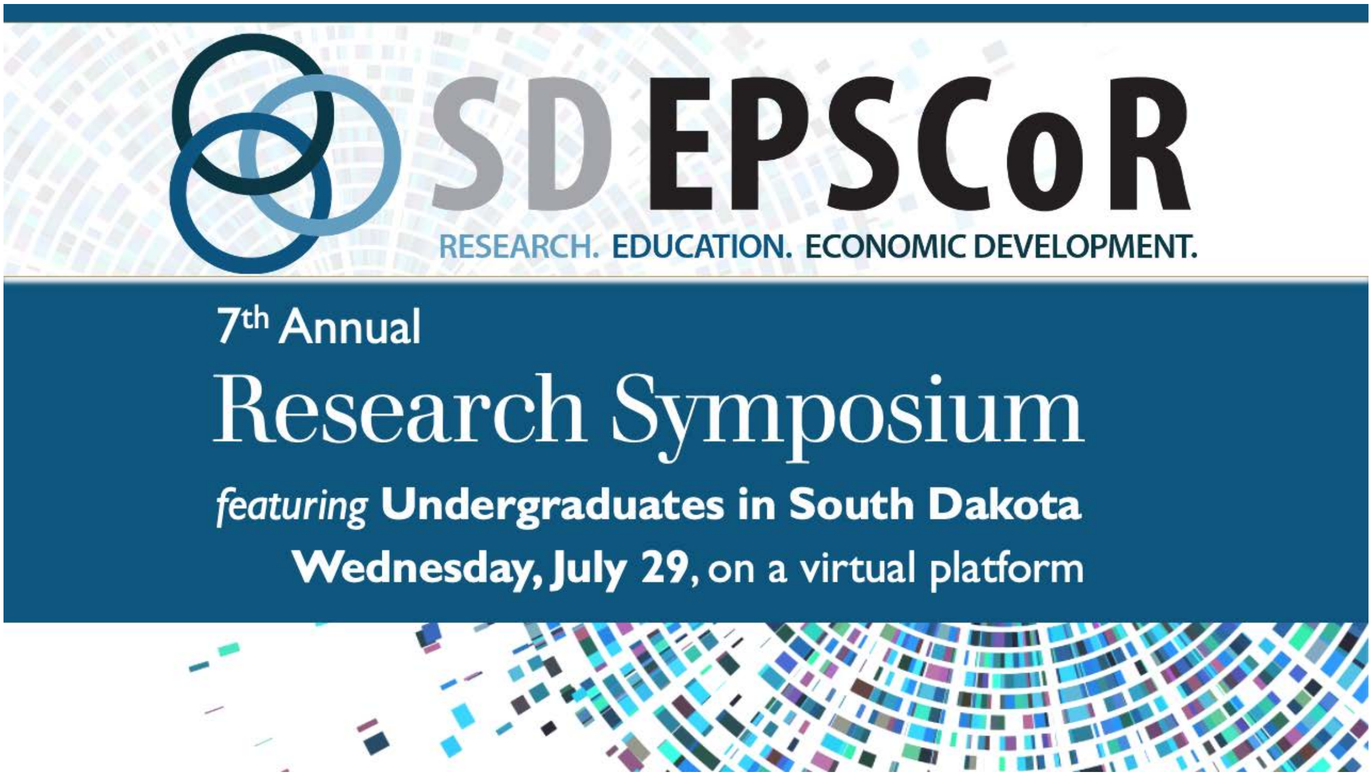

2020 SD EPSCoR Virtual Symposium for Undergraduate Research

Statewide Virtual Presentation **July 29, 2020**

2020 SD EPSCoR Virtual Symposium for Undergraduate Research, Statewide

July 29, 2020

Presentation Agenda; all times listed are CDT

Wednesday July 29	**Virtual Research Symposium Digital Call**
1:00 - 1:05 p.m.	Welcome, announcements and technical setup
1:05 - 1:30 p.m.	Presentation pitches given by all presenters
1:30 - 1:50 p.m.	Presentation Session 1 in small groups

Group 1: Chemistry (Moderated by Bhuvan Vemuri)

1a: Ronning
1b: Koble
1c: Weckwerth

Group 2: Computational Analysis (Moderated by Jessica Zylla)

2a: Gadhamshetty *et al.*
2b: Subedi *et al.* (Subedi, Kaflay)
2c: Hartman *et al.* (Hartman, Radichev)

Group 3: Astrobiology (Moderated by Sonya Erlandson)

3a: Dewitt *et al.* (Dewitt, Maloney, Drummond, Mulu)

Group 4: Education (Moderated by John Williams)

4a: Cryan *et al.*
4b: Lenz *et al.*
4c: Ireland

Group 5: Biofilms (Moderated by Saurabh Dhiman)

5a: McLaughlin
5b: Becker, Holmes
5c: Giles, Tordsen

Group 6: Pharmaceutical and Health Sciences (Moderated by Mel Ustad)

6a: Ross
6b: Goeden, Samuelson

1:50 - 2:00 p.m.	*Break*
2:00 - 2:20 p.m.	Presentation Session 2 in small groups The Session 2 groups will be the same as the Session 1 groups.
2:20 - 2:30 p.m.	Closing announcements and wrap-up

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2020 SD EPSCoR Virtual Research Symposium Researcher Abstracts

1a — Saturated Absorption Spectrometer for Laser Frequency Calibration

Eleanor Ronning, Dr. Andrew Klose
Augustana University

Abstract: A saturated absorption spectroscopic setup was constructed to measure hyperfine spectra of molecular iodine. The well-known absorption features of molecular iodine will be used to calibrate probe lasers used for collinear laser spectroscopy of rare isotopes at the National Superconducting Cyclotron Laboratory. A pump and probe beam, split from a common laser using, were counter propagated through a 60-cm-long iodine vapor cell. The frequency of the laser light was scanned, and the probe laser beam was modulated on-and-off. A lock-in amplifier was used to demodulate the probe laser light signal to eliminate the Doppler-broadened background and obtain the saturated absorption spectrum. An external cavity diode laser (ECDL) emitting near 780 nm light was constructed and optimized as the laser system for the setup; the ECDL was characterized with a monochromator and a Michelson interferometer was assembled to ensure its stability. An electro optic modulator was tested and characterized and is planned to be integrated into the setup to either independently scan the probe laser frequency, or alternatively to perform frequency modulation spectroscopy. A data acquisition system was developed to monitor temperature and pressure shifts using Python to interface with a LabJack U3 streaming unit. The design and setup of the spectrometer will be presented, and future applications of the apparatus will be discussed.

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1b — Modeling and Fitting Molecular Iodine Hyperfine Spectra in Python

Makenna Koble, Dr. Andrew Klose
Augustana University

Abstract: An iodine saturated absorption spectrometer has been constructed to calibrate a laser for precision laser spectroscopy studies of rare isotopes at the National Superconducting Cyclotron Laboratory at Michigan State University. Accurately modeling and fitting experimental iodine hyperfine spectra is imperative for a precise determination of laser frequency. For a given ro-vibrational level in iodine, the hyperfine spectrum consists of 15 or 21 hyperfine levels that are described by the effective hyperfine Hamiltonian. Coupling between many hyperfine levels must be considered; thus, the energy of each hyperfine level is obtained by diagonalizing a Hamiltonian matrix, comprised of either 45 or 63 states for both the lower and upper levels of the iodine transition. In this work, a Python-based program was written to construct and diagonalize the hyperfine Hamiltonian. After matrix diagonalization, the spectrum can be modeled as a function of four hyperfine coupling constants for both the ground and excited levels. Additionally, a nonlinear curve fitting routine was implemented to fit a full iodine hyperfine spectrum and deduce the hyperfine coupling constants and hyperfine spectrum centroid. The coupling contributions from the 45 or 63 states is considered during the fitting routine allowing precise fitting of all 15 or 21 hyperfine transitions simultaneously to deduce a single centroid value for the transition. The creation of this application will be presented, and future prospects using this tool for laser frequency calibration will be discussed.

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1c — Measuring Diffusion with Colorimetrically with Microcontrollers

Eleanor Carol Weckwerth, Dr. Andrew Klose
Augustana University

Abstract: Diffusion of substances in solution is a topic often studied in undergraduate physical chemistry courses. Here, a method to measure diffusion using colored solutions and arduino microcontroller-based colorimeters was developed to demonstrate the concept of diffusion and to measure diffusion coefficients. An arduino-based colorimeter, using an inexpensive light emitting diode and phototransistor was constructed and characterized; the colorimeter exhibited linear absorption as a function of concentration for absorption values less than 1. Multiple colorimeters were then placed in 3D-printed holders perpendicular to a fritted capillary tube that initially held water. The fritted tube was inserted into a bath of concentrated food coloring, and the food coloring diffused up the tube. The rate of diffusion was measured colorimetrically at three points along the tube; data were saved on a PC using a Python-based control script that communicated with the arduino. After the experiment, the data were analyzed using another Python-based script that fit the data using the known solution to Fick's diffusion laws and allowed the diffusion coefficient to be elucidated. The construction and characterization of the apparatus will be presented. Data analysis and future prospects will also be discussed.

Funding Organization: REU

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2a — Computational Models for Predicting Biofilm Properties

Rushil Gadhamshetty, Govinda Chilkoor, Rajesh Sani, Dr. Venkataramana Gadhamshetty, Hafizur Rahman, Shankarachary Ragi
South Dakota School of Mines & Technology

Abstract: Biofilm forms on virtually every imaginable environment on the earth. Although biofilms seem to barely interfere with human activities, they can be extremely beneficial and at times quite dangerous. The current study presents a glimpse of ongoing research at SDSMT led by NSF Data Driven Material Discovery Center for Bioengineering Innovations center. Here, we will share details of ongoing work on computational models for studying biofilm phenotypes in response to changes in the environments. We'll develop a deep neural network to segment biofilm microscopy images based on object categories including bacterial cells (individual and clustered) and extracellular polymeric substances. Based on this segmentation, we can determine coverage area of the bacterial cells using an image pixel counting approach. We'll use DeepLabV3 for image annotation and deep neural network training. Once we train our deep learning models, we can perform image segmentation on biofilms and extract quantitative biofilm phenotypes (e.g., area covered by bacterial cells), and classify the images into classes including bare Cu, bare low-carbon steel (LCS), Cu covered with biofilm, and LCS covered with biofilm. Simply put, we will analyze behavior of microorganisms and predict what physiological conditions, including material surfaces, enable their growth, help them thrive or stagnate. We present a case study based on biofilms of sulfate reducing bacteria grown on metal surfaces intentionally modified with conformal coatings of two dimensional (2D) materials. The practical implications of this study are to discover new material solutions for solving pressing biofilm problems facing the modern society.

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2b — Biofilm-DIDS v0.9: A Search Engine for Biofilm-Material Data and Information Discovery System

Subrat Subedi, Sabi Kaflay, Peter Upton, Dr. Etienne Gnimpieba
University of South Dakota

Abstract: The main objective is to develop an extraction module to retrieve the most relevant dataset to populate our Biofilm-DIDS. The Bioinformatics Tool Discovery System (Bio-TDS, biotds.org) was developed to assist researches in retrieving the most applicable analytic tools by allowing them to formulate their questions as free text. One of the primary components of the Bio-TDS is data mining, ontology, and natural language processing workflow for annotation, curation, query processing, and evaluation. We are working with SDSMT on a project that would integrate BioTDS into a Biofilms Data and Information Discovery system (Biofilm-DIDS). Biofilm-DIDS aims to collect and combine disparate big datasets pertinent to biology and material scientist, use artificial intelligence (computer vision and machine learning approaches) to analyze and predict gene responses and biofilm phenotypes impacted by nanosomic surficial properties. The team currently identified 48 microbe and phenotype database of interest and integrate 2 datasets in our working version. The Biofilm-DIDS platform is comprised of four core modules including: 1) the Biofilm Data Fusion, 2) Modeling and Data-driven approaches, 3) the Natural Language Query Processor (NLP), and 4) the Query Log module. The data fusion module retrieves, curates, annotates and indexes metadata from the public data sources. The indexes then be integrated with the project's experimental data sets. We extract existing data sets and synthesize new data sets related to 2-D materials, transcriptomics, proteomics, metabolomics, methylome, phenotypic information. Biofilm-DIDS store reference collections and other data needed to validate the biofilm hypotheses generated as a query result and return the biofilm phenotypes as function of 2-D material properties. The current version of Biofilm-DIDS contain over 1200 2-D materials and 10 Biofilms entries. Leveraging literature text mining and database integration from Material Genome Project initiative, we aim to reach more than 10,000 2-D Materials and 100 biofilms. This will include core materials properties involved in biofilm development life cycle.

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2c — Data-driven 3-D Scaffold Printing Using 2-D Material-based Ink

Tim Hartman, Evgeni Radichev, Gideon Kassa, Dr. Etienne Gnimpieba
University of South Dakota

Abstract: Background: Big data is available from multiple fields for each biological level—from genes to organs. We will use data mining to discover new biomaterials and 3D scaffold models to more accurately replicate human biological conditions. Researchers may pull from this discovered data to strengthen their experiments with better materials and 3D-printable scaffolds.

Problem: It is a challenge to replicate the 3D microstructure that mimics a body part. Moreover, organ tissues are composed of different materials, but many 3D printers can print only one material at a time. The combination of these issues creates the need for an accessible method for material and scaffold structure selection. Such a method should ensure accurate, reproducible results to improve disease treatment.

Solution: We will create a data mining process to leverage existing material and biological structure data. By using the models generated we can help researchers design and create customized scaffolds using 3D printing technologies.

Current progress: One of our discovery tools is an accessible image-analysis tool that quantifies differences in image sets and can help identify biomaterial similarities and cellular treatment effects. We are also developing an open database for bioimages and their extracted data. Additionally, Biovisualizer will utilize R and Python to give interactive and comprehensible 3D graphs. As for printing, we have been able to extrude several materials using our Allevi 2 bioprinter.

Future work: Our three software tools are in their development stage. We want to publish these tools soon so that we can begin populating them with image data. We will be improving our printing capabilities in tandem with the software development. The print settings must be refined for each material while we expand our available material and printer options.

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3a1 — Assessing Kinetics of Conversion of a Representative Solar System Polycyclic Aromatic Hydrocarbon to a Potentially Biologically Important Quinone on Mineral Substrates: Implications for Origins of Life

Jared Dewitt, Christina Maloney, Sarah Gonzalez Henao, Vytis Karanauskas, Christina Mulu, Samuel Drummond, Dr. Bethany Theiling, Dr. Laura Barge, Dr. Patrick Videau, Dr. Michael Gaylor
Dakota State University
Iowa State University
Southern Oregon University
Instituto de Astrobiología de Colombia, Bogotá
NASA Goddard Space Flight Center
ASA Jet Propulsion Laboratory, California Institute of Technology

Abstract: Polycyclic aromatic hydrocarbons (PAHs) are ubiquitous in astrochemical environments and are disbursed into planetary environments via extraterrestrial infall where they may undergo reactions on mineral surfaces to produce biomolecular precursors (e.g. quinones) important for origins of life chemistries. To address the reasonableness of this idea, we assessed the potential of the clay minerals montmorillonite (MONT), kaolinite (KAO) and a Mojave Mars soil simulant (MMS) to catalyze conversion of the PAH anthracene (**1**) to 9,10-anthraquinone (**2**) – a redox compound believed important for the emergence of life on the ancient Earth and perhaps on other planetary bodies (e.g. Mars and Ceres). All mineral substrates catalyzed conversion of **1** to **2** over temperatures encompassing a wide range of astrochemical environments (25-500 oC). Apparent rates of conversion displayed a sigmoidal relationship for MONT and KAO, while MMS displayed a quadratic relationship. Efficiencies of **2** conversion were 2.9, 1.7, and 0.7% for MONT, KAO, and MMS, respectively. Efficiencies of **2** conversion on MONT were about two orders of magnitude greater than those reported in our previously published study in which reactions were carried out in larger volume crucibles[1]. We hypothesize that observed differences in catalytic efficiencies are due to differential binding of **2** to the substrates and correspondingly increased loss (presumably due to sublimation). These findings improve significantly upon our previously reported MONT-catalyzed conversion efficiencies[1] and provide empirical support for a plausible scenario in which interactions of solar system PAHs and planetary minerals produce biologically relevant quinones in prebiotic planetary environments.

1. Juntunen, HL; Leinen, LJ; Pitts, BK; O'Hanlon, SM; Theiling, BP; Barge, LM; Videau, P; Gaylor, MO. Investigating the Kinetics of Montmorillonite Clay-Catalyzed Conversion of Anthracene to 9,10-Anthraquinone in the Context of Prebiotic Chemistry. *Orig. Life Evol. Biosph.* **201** , 48, 31-330.

Funding organization: SD EPSCoR

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3a2 — Characterizing Sublimation Kinetics of a Representative Solar System Polycyclic Aromatic Hydrocarbon and its Quinone Byproduct from Planetary Relevant Mineral Substrates Under Simulated Prebiotic Conditions: Implications for Origins of Life

Christina Maloney, Jared Dewitt, Christina Mulu, Samuel Drummond, Sarah Gonzalez Henao,Vytis Karanauskas, Dr. Bethany Theiling, Dr. Laura Bargee, Dr. Patrick Videau, Dr. Michael Gaylor
Dakota State University
Iowa State University
Southern Oregon University
Instituto de Astrobiología de Colombia, Bogotá
NASA Goddard Space Flight Center
ASA Jet Propulsion Laboratory, California Institute of Technology

Abstract: Polycyclic aromatic hydrocarbons (PAHs) are ubiquitous in astrochemical environments and are deposited into planetary environments via extraterrestrial infall where they may undergo reactions on mineral surfaces to produce biomolecular precursors (e.g. quinones) important for origins of life. To address the reasonableness of this idea, we have previously assessed the potential of the clay minerals montmorillonite (MONT) and kaolinite (KAO) and a Mojave Mars simulant (MMS) to catalyze conversion of the PAH anthracene (**1**) to 9,10-anthraquinone (**2**) – an electron transport compound believed important for the emergence of life on the ancient Earth and perhaps on other planetary bodies (e.g. Mars and Ceres)1. There, all mineral substrates catalyzed conversion of **1** to **2** over temperatures encompassing a wide range of astrochemical environments (25-500 ^{o}C). Apparent rates of **2** conversion displayed a sigmoidal relationship on MONT and KAO, while MMS displayed a quadratic relationship. We hypothesized that concomitant loss of **1** and **2** (presumably via sublimation) would account for the **2** conversion trends observed in that study. To test this, we doped MONT, KAO, and MMS with pure **1** and **2** and incubated aliquots of these substrates over the temperature range 100-500 ^{o}C. Apparent loss rates for **1** and **2** were exponential on all substrates. Loss rates for **1** were in the order MMS > MONT > KAO, while loss rates for **2** were in the order of MONT >> KAO > MMS. Differential substrate binding likely accounts for the loss trends observed in this study and the **2** production trends observed in our previous study[1]. Though sublimation of **1** and **2** would limit production of the biologically relevant **2** in hotter planetary environments (e.g. impacting meteorites and hydrothermal systems), it would also disseminate both compounds into those environments to participate in prebiotic reactions that may influence origins of life chemistries.

1. Gonzalez, SH; Karanauskas, V; Dewitt, JT; Maloney, CM; Mulu, CY; Drummond, SM; Theiling, BP; Barge, LM, Videau, P; Gaylor, MO. Assessing Kinetics of Conversion of a Common Solar System PAH to a Potentially Biologically Important Quinone on Planetary Relevant Mineral Substrates: Implications for Bioemergence in Prebiotic Planetary Environments. In preparation for immediate submission to the journal *Astrobiology*.

Funding organization: SD EPSCoR

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3a3 — Investigating UV-Catalyzed Conversion of a Representative Solar System Polycyclic Aromatic Hydrocarbon PAH to a Potentially Biologically Important Quinone on Planetary Relevant Mineral Substrates: Implications for Origins of Life

Samuel Drummond, Christina Maloney, Christina Mulu, Jared Dewitt, Dr. Bethany Theiling, Dr. Laura Barge, Dr. Patrick Videau, Dr. Michael Gaylor
Dakota State University
Iowa State University
Southern Oregon University
Instituto de Astrobiología de Colombia, Bogotá
NASA Goddard Space Flight Center
ASA Jet Propulsion Laboratory, California Institute of Technology

Abstract: Polycyclic aromatic hydrocarbons (PAHs) are abundant in astrochemical environments and are deposited to planetary environments via extraterrestrial infall where they may undergo UV-catalyzed reactions on mineral surfaces to produce biomolecular precursors (e.g. quinones) that influence origins of life chemistries. To address the reasonableness of this idea, we assessed the catalytic potential of the clay minerals montmorillonite (MONT) and kaolinite (KAO) and a Mojave Martian Soil simulant (MMS) to catalyze conversion of the PAH anthracene (ANTH) to 9,10-anthraquinone (ANTHQ) – a redox compound believed important for the origins of life on the primordial Earth and on other planetary bodies (e.g. Mars and Ceres) – in the presence of sunlight. ANTH-doped substrates were exposed to natural sunlight at 2-hour intervals from early morning to evening over three days with comparable weather and UV regimes. Highest ANTHQ conversion yields were observed during early afternoon, correlating with highest solar UV flux. Maximum ANTHQ conversion efficiencies were 0.24, 2.34, and 0.49% for MONT, KAO, and MMS, respectively. No ANTHQ conversion was observed in the absence of mineral substrates. To delineate thermal- and UV-driven ANTHQ conversion, ANTH-doped substrates were incubated in the lab under the same time and temperature regimes of the sunlight exposures. Thermal ANTHQ conversion was < 1% for all substrates, confirming that solar UV, rather than solar heating, drives these reactions. Our findings provide empirical support for a plausible scenario in which potentially biologically important quinones are produced on catalytic mineral surfaces in the presence of solar radiation in prebiotic planetary environments. Current work is focused on delineating the effects of UV intensity and total UV flux, and the effects of UVA, UVB, and UVC on ANTHQ conversion.

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3a4 — Preliminary Assessment of the Catalytic Potential of a Suite of Planetary Relevant Mineral Substrates to Convert a Solar System Polycyclic Aromatic Hydrocarbon to a Biologically Relevant Quinone: Implications for Origins of Life

Christina Mulu, Jared Dewitt, Sarah Gonzalez Henao, Vytis Karanauskas, Christina Maloney, Samuel Drummond, Dr. Bethany Theiling, Dr. Laura Barge, Dr. Patrick Videau, Dr. Michael Gaylor
Dakota State University
Iowa State University
Southern Oregon University
Instituto de Astrobiología de Colombia, Bogotá
NASA Goddard Space Flight Center
ASA Jet Propulsion Laboratory, California Institute of Technology

Abstract: Polycyclic aromatic hydrocarbons (PAHs) are abundant in astrochemical environments and are disbursed into planetary environments via extraterrestrial infall. We hypothesize that, once deposited, PAHs undergo reactions on mineral surfaces to produce biomolecular precursors (e.g. quinones) that could have driven origins of life on Earth and perhaps on other planetary bodies (e.g. Mars, Ceres, Europa). To investigate the reasonableness of this idea, we assessed the potential of a suite of planetary relevant mineral substrates to catalyze conversion of the solar system PAH anthracene (ANTH) to 9,10-anthraquinone (ANTHQ) – an electron transport compound believed important for origins of life chemistries. We compared catalytic potentials to those measured under median conditions assessed in our previous study of the catalytic potentials of phyllosilicate clay minerals and a Mars regolith simulant[1]. Conversion of ANTH to ANTHQ was observed in all but one substrate, with mean conversion on all other substrates ranging from 2511 ± 37 ng mg^{-1} of ANTH for iron sulfide (FeS) to 79,411 ± 5279 ng mg^{-1} of ANTH for magnetite (Fe_3O_4). Additional compounds were detected in all but the iron phosphide (Fe_3P) and FeS extracts, including several quinones recently measured in meteorite extracts and shown to facilitate chemiosmosis in cell membranes[2]. Our findings provide empirical support for a plausible scenario in which interactions of solar system PAHs with diverse planetary minerals produce biologically relevant quinones that could drive origins of life chemistries in prebiotic planetary environments.

1. Gonzalez, SH; Karanauskas, V; Dewitt, JT; Maloney, CM; Mulu, CY; Drummond, SM; Theiling, BP; Barge, LM, Videau, P; Gaylor, MO. Assessing Kinetics of Conversion of a Common Solar System PAH to a Potentially Biologically Important Quinone on Planetary Relevant Mineral Substrates: Implications for Bioemergence in Prebiotic Planetary Environments. In preparation for immediate submission to the journal *Astrobiology*.
2. Milshteyn, D; Cooper, G; Deamer, D, Chemiosmotic Energy for Primitive Cellular Life: Proton Gradients are Generated Across Lipid Membranes by Redox Reactions Coupled to Meteoritic Quinones. Sci. Rep. **2019**, 9 (1), 12447.

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4a — SD EPSCoR Intern Research

Chantel Cryan, Debra Wolf, Dr. Ben Sayler, Peggy Norris, Dr. Becky Bundy, Julie Dahl, Nicol Reiner
Black Hills State University

Abstract: Over the 2020 summer, interns from Black Hills State University have been working for SD EPSCoR, with educational outreach efforts to provide SD STEM educators access to quality curriculum support materials that are connected to the current and relevant applications of biofilm research happening in South Dakota. The work during this internship has been focused on participating and giving feedback during the K-12 science professional development workshop, as well as, collecting and organizing research and education resources, phenomena, and applications related to biofilms brainstormed by EPSCoR researchers and STEM educators that will be used to forward the development of future curriculum modules. The interns' involvement with this work provided the opportunity to learn from and alongside veteran educators during the science professional development workshop which provided insight to what quality curriculum units look like using phenomena and implementing 3-Dimensional learning strategies. The interns have been utilizing what they learned from the science professional development to translate assemblies and field trips put on by the Sanford Underground Research Facility's Education and Outreach department into a virtual format. The major personal and professional take-aways from this internship include building connections with researchers and educators and collecting resources that will be invaluable to the interns' future career in science education. The interns work with SD EPSCoR and its educational outreach efforts are vital in educating the public about biofilm research in South Dakota and will change the way educators teach science.

Funding organization: SD EPSCoR

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4b — Teaching the Unsettled Science

Taylor Kay Lenz, Debra Wolf, Peggy Norris, Nicol Reiner, Becky Bundy, Julie Dahl, Shantel Cryan, Dr. Ben Sayler
Black Hills State University

Abstract: The education internship for EPSCoR connected the Sanford Underground Research Facility's (SURF) Education and Outreach (E&O) department with science education interns from Black Hills State University. The intention of the position was to learn from and with SURF's E&O team as well as other STEM educators throughout the state of South Dakota. During the first three weeks, interns participated in professional development through a biofilm unit example alongside approximately 200 other experienced educators. The interns were able to professionally network with seasoned K-12 teachers from diverse content areas. During these collaborations, interns served the essential role of offering different experiences, expertise, and insights. In the following weeks, the interns curated resources for curriculum development. Those resources included accessible phenomena, content progressions, and instructional supplements based on student-lead investigations to prompt students to explore the unsettled science of EPSCoR research. The research for this curriculum development came from many sources including a literary search, direct data from primary EPSCoR researchers, the Next Generation Science Standards, the National Science Teaching Association, SURF Professional Development, databases, libraries, veteran teachers, faculty blogs, and education supplement sites. The results of the research were used to guide and inform the creation of five curriculum units: two elementary, one middle, and two high. Furthermore, in response to the ongoing circumstances of the COVID-19 pandemic, the interns used their experience of professional development in a virtual format to translate established face-to-face field trips, assembly programs, and the annual Neutrino Day Festival into interactive virtual experiences. A fundamental consideration when doing so was preserving the integrity of the established interactive student experience in the transition. Overall, the EPSCoR education internship provided the science education interns with insight and practical experience into science teaching through professional development, networking, resource creation, and modeling of effective virtual learning.

Funding organization: SD EPSCoR

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4c — EcoForged Education Modules: Innovative Plastic Waste Education for South Dakota Students and the General Public

Faith Ireland, Dr. Brennan Jordan
University of South Dakota

Abstract: Today, plastic materials permeate every area of our culture and serve many vital functions, which has led to an abundance of plastic waste. The EcoForged project seeks to create sustainable building materials from recycled plastic and research the scope of South Dakota's plastic waste recycling education. We found that plastic recycling education has not been historically accessible to students within the state's K-12 education system. After interviewing nine educators across the state within the five effective education bands, K-2, 3-5, 6-8, 9-12, and the general public, we found a lack of recycling education within South Dakota school systems. The EcoForged Project is tackling this issue by creating education modules, based upon South Dakota learning standards from Science, Social Science, Visual Arts, and English standards. Our results of this research project indicate the most effective style of plastic waste education is based on cognitive abilities, interests, and learning standards of the five education bands. However, there is little research into sufficient lesson length per group. During our study, educators reported that students with different cognitive abilities learn and engage with topics differently. Therefore, the modules should reflect their abilities. This information led us to create a series of hands-on plastic recycling educational modules for use in South Dakota K-12 classrooms and formatted for the appropriate length and content. To address the discrepancies between South Dakota classrooms, the modules will be available within kits or online. The module's content is designed to build upon one another as students progress from K-12 to give South Dakota teachers consistent and research-backed resource for additional environmental and sustainability education. Finally, to create broader impacts across the state, the EcoForged Project Team is developing a competition in which students can collect recycled plastic, create something new, and discuss how local solutions can have global impacts.

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5a — Genetic Factors of Biofilm Inhibition in Stenotrophomonas maltophilia Using Zingerone — A Mutagenesis Study

Nolan Patrick McLaughlin, Dr. Jon Mitchell, Dr. Andrew Russell
Northern State University

Abstract: While there are a few examples of beneficial bacterial biofilms, (i.e. normal microbiota, nitrogen fixation in plant roots, etc.), the majority seem to be a nuisance in nearly all aspects of society. They have the ability to cause severe infections in humans, disrupt industrial production, and decrease the overall cleanliness of our daily lives. Therefore, new products and strategies are needed to prevent biofilms from forming on a variety of surfaces. Preliminary research performed indicates that a natural compound called zingerone disrupts biofilm production on a variety of bacterial species on contact lenses and other abiotic surfaces. However, the exact mechanism zingerone uses to inhibit biofilm production in some bacterial species remains unclear. Our proposed research seeks to understand the genetic and molecular requirements for zingerone activity in the bacterium Stenotrophomonas maltophilia. Currently in trial, a reverse genetics approach utilizing a transposon mutagenesis study is seeking to create rescue mutations to recover the biofilm forming genes while in the presence of zingerone. Subsequent genome isolation and sequencing of the rescued mutant(s) could elucidate the gene(s) presumably involved in biofilm formation. This information would be valuable for medical and industrial applications because it could help us develop better chemicals and prevention strategies to block biofilm production and to better understand novel genes needed to produce biofilms.

Funding organization: REU

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5b — Exploration and Characterization of Antimicrobial Factors of Placenta on *S. aureus* Biofilms

Jason Matthew Becker, Ellie Holmes, Dr. Paul Egland
Augustana University

Abstract: Biofilms, the growth of bacteria on a surface, are the predominant mode of growth for bacteria. The formation of biofilms occurs on industrial surfaces, such as pipelines and medical devices, as well as on biological surfaces, such as teeth and wounds. Since adherence to surfaces is an early event in infection, biofilm formation poses a special problem in wound care. Furthermore, bacteria in biofilms are less susceptible to antibiotics. One solution may be the use of antimicrobial factors found in placentas. Here, we demonstrate that placenta extract inhibits *S. aureus* biofilm formation. Placenta from four different species was separated into maternal and fetal portions. *S. aureus* biofilms were treated with placenta extract separated into either maternal, fetal, boiled, or unboiled portions and grown overnight. Of all the treatments, the fetal portion of boiled cow placenta was found to be most effective at inhibiting biofilm growth. The results of this research provide a promising avenue for the use of placenta tissue in wound treatment.

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5c — Aphanomyces Root Rot of Alfalfa Disease Survey in South Dakota

Jennifer Marie Giles, Connor Lee Tordsen, Dr. Andrew Sathoff
Dakota State University

Abstract: Alfalfa is the third most valuable crop grown throughout the United States. Its high protein content makes it a nutritious crop, important for feeding livestock. *Aphanomyces euteiches* is an oomycete pathogen that causes Aphanomyces root rot of alfalfa, which inhibits alfalfa growth in seedling and adult stages. There are currently no chemical controls against *A. euteiches.* Common management practices are crop rotation and planting of resistant alfalfa varieties. *A. euteiches* can survive for long periods in soil, and its high genetic diversity allows it to remain virulent against many alfalfa varieties. Without current studies establishing the presence and distribution of *A. euteiches* in South Dakota, there is a need for soil surveillance and isolation of *A. euteiches* to aid growers in the selection of resistant alfalfa lines with the aim of increased production. Fields across eastern South Dakota were surveyed to collect composite soil samples. Fields were sampled in 16 counties including: Beadle, Brookings, Brown, Brule, Codington, Day, Faulk, Hamlin, Kingsbury, Lake, Lincoln, Miner, Minnehaha, Moody, Spink, and Turner. In growth chamber assays, alfalfa cultivars of differing resistance were grown in the collected soil samples for Aphanomyces isolation and race-typing. Seedlings were rated for disease severity using a standardized rating system. The ability of Aphanomyces to infect certain lines of seedlings determined the races of the pathogen present in the soil samples. *A. euteiches* detection was further validated through DNA extraction and PCR with Aphanomyces specific primers. Also, samples of infected root tissue were placed on selective media, and *A. euteiches* was isolated. Race-typing, PCR, and root isolation all demonstrated the presence of *A. euteiches* in South Dakota. This study establishes the presence of race 1 and race 2 of *A. euteiches* in South Dakota and will help guide growers to select alfalfa varieties that will produce the highest yields.

Funding organization: REU

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6a — Development of Fluorinated MAO-B Inhibitors as Potential Drug Candidates for Alzheimer s and Parkinson s Disease Through Molecular Docking

Belle Elizabeth Ross, Dr. Anjaneyulu Putta, Dr. Haoran Sun,
University of South Dakota

Abstract: Neuroinfllmation is a key factor in the diagnosis and prognosis of neurodegenerative diseases such as Alzheimer's Disease (AD), Parkinson's Disease (PD), Amyotrophic lateral more sclerosis (ALS), and Huntington's Disease (HD). Due to the complexity of the human brain, drug development for these diseases face various obstacles in identifying the correct target protein including: locating the receptor's active site, developing an inhibitor or activator that is highly selective, and ensuring the compound is able to cross the blood brain barrier. Monoamine oxidase B (MAO-B) is one of the key targets to develop drugs for the treatment of AD and PD. Currently there are two common MAO-B inhibitors, Selegiline and Rasagiline, which are used only for relieving the symptoms of PD not the cause, which signifies the necessity for designing of new and potent MAO-inhibitor drug molecules. Fluorine plays an important role in the development of drug molecules in various diseases due to its high electronegativity and small size. In this computational research project, we aim to develop fluorinated compounds that have better binding affinity (lower Ki) than Rasagiline using molecular docking. Early results indicated that the trifluoromethyl-substituted derivative showed better binding affinity (22.47 µM) compared to the existing MAO-B inhibitor Rasagiline (28.5 µM). The lead fluorinated compounds will be pursued further for synthesis in our lab.

Funding organization: REU

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6b1 — Computational Modeling of the Thermodynamics of the Aromatic, Nucleophilic Substitution of Sanger's Reagent

Brock Gerard Goeden, Brady Samuelson, Dr. Haoran Sun
University of South Dakota

Abstract: Derivatization of polypeptides via reactions with 2,4-dinitrofluorobenzene and subsequent fluorescent detection of individual amino acids was an invaluable method of protein sequencing before the implementation of LC-MS tandem spectrometry. The nucleophilic aromatic substitution of fluorine on 2,4-dinitrofluorobenzene is not exclusive to amino acids, however. In this project, I will investigate the thermodynamics of this nucleophilic aromatic substitution with aromatic amines. Utilizing computational modeling and the thermodynamic data of these reactions, applications for use in pharmaceutical design and ligand binding will be investigated. My results will be further explored to probe for viability in an experimental setting.

Funding organization: SD EPSCoR

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6b2 — Modeling the Reaction Kinetics of the Nucleophilic Aromatic Substitution of Sanger's Reagent

Brady Paul Samuelson, Brock Goeden, Dr. Haoran Sun
University of South Dakota

Abstract: 1-fluoro-2,4-dinitrobenzene, commonly known as Sanger's reagent was an important compound used in the detection of amino acids and the sequencing of proteins before the employment of LC-MS. However, the use of 1-fluoro-2,4-dinitrobenzene is not limited to solely amino acids. For my research, I will investigate the reaction kinetics of the aromatic nucleophilic substitution with aromatic amines. Application of computational modeling and thermodynamic data of these reactions to search for utilization in both pharmaceutical synthesis and ligand binding will be carried out. Further, the results will be used to test experimental viability.

Funding organization: SD EPSCoR

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