Student Research Poster Display

Caputo Hall Lobby

October 23-29, 2019

Biology ***Chemistry***

Earth Sciences ***Physics***

Millersville University

College of Science and Technology

Welcome Message from the Dean

On behalf of everyone in the College of Science and Technology, welcome to the 19th Annual Fall Student Research Poster Display. In your program, you will find a sampling of abstracts of student/faculty research that are representative of the excellent and innovative work being done within the College.

Student/faculty research has a rich history at Millersville University with the goals of this event being to

- celebrate the breadth of research inquiry and scholarly activity within the College,
- promote and create a sense of excitement about the research students and faculty are collaboratively engaging in, and
- recognize the hard work and dedication of our students and faculty.

Engaging undergraduates in research is critical to a student's development as a scholar and innovator as well as a key feature in Millersville University's strategic plan, *Our Bold Path*. Identified as a high-impact practice, research experiences place the content knowledge students learn in the classroom into the context for how it is used within the discipline and by practitioners in the field. I would like to thank Dr. Aaron Haines and Mrs. Marianne Frantz for organizing the event. I would like to thank the students for taking the initiative to participate in this activity as well as the faculty for making the time to mentor and guide our students through the investigative, creative, and discovery process. Thank you for creating and facilitating this outstanding opportunity for our students.

I hope you enjoy perusing the poster displays and the fine work performed by our students and faculty. It is yet another example illustrating how Millersville University students excel!

Sincerely,

Michael Jackson
Dean, College of Science and Technology

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Biology

1. Host Defenses and the Evolution of Disease

*Dais, Evelyn and Stieha, Christopher R.**
Department of Biology, Millersville University, Millersville, PA 17551

Disease-host interactions consist of the host defending itself against the disease and the disease's evolving counter-strategies against these defenses. Two common defenses against disease are resistance and tolerance. Host resistance either decreases the likelihood that the host will contract the disease or increases the host's recovery rate. Tolerant hosts do not exhibit a decreased lifespan or reproductive rate when infected with a disease. To quantify the effect of host defenses on competition and dominance between strains of a disease, we simulated a Susceptible-Infected-Susceptible mathematical model (SIS), where susceptible individuals could be infected by one of two strains and hosts differed in their defenses against said strains. Host tolerance to a strain, whether affecting lifespan or reproductive rate, appeared to have no effect on which strain dominated. With respect to host resistance, the strain that dominated was the strain to which the host was least resistant. There appeared to be no interaction between host tolerance and host resistance and which strain dominated. From our results on competition, disease mitigation should focus on resistance mechanisms, such as vaccinations, as opposed to tolerance mechanisms, but further work is needed on the population dynamics of the host and disease strains, such as minimizing the total number of hosts infected.

* faculty mentor

Biology

2. Investigation of the Potential Reprogramming of Turtle Neural Crest Cells

*Sterner, Molly, and Cebra-Thomas Judith**
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The turtle shell is a novel structure that creates an exoskeleton of bone. The origin of the ventral plastron is unknown, but it is formed through intramembranous ossification, similar to that of the facial bones. Previous evidence suggests the plastron bones are formed from migrating neural crest cells (NCCs). These cells form a variety of structures, but NCCs below the cranial region have not been shown to contribute to the skeleton previously. This suggests that the NCCs that form the turtle plastron (originating in the lower body or trunk) must have something that makes them "cranial-like". Investigation of the gene expression profile in turtle NCCs has shown that they express a number of transcription factors that have previously been considered cranial-specific in the chicken. To test if the NCCs have been reprogrammed to allow them to make bone, their gene expression was analyzed. The production of fluorescent proteins linked to enhancers (DNA sequences that control gene expression) used in NCCs from the head and body were compared. As expected, the trunk NCCs from young embryos (stage G10), which are thought to be comparable to NCCs in other types of vertebrate embryos, utilize the trunk-specific enhancer. Unexpectedly, the trunk NCCs from older embryos (stage G16), which are thought to be responsible for forming the plastron, did not show strong expression from either the trunk-specific or the cranial-specific enhancer. This does indicate that there may be a difference between younger and older turtle trunk NCCs, and the weak expression of the cranial enhancer may have resulted from technical issues with the way in which the expression plamids were introduced. However, the experiment does not provide evidence for a large scale reprogramming of the NCCs that produce the bones of the plastron.

* faculty mentor

Chemistry

3. Progress Toward the Synthesis and Chemistry of 1-Aroyldiaziridines

Sharrow, Jessica; Ostopowicz, Lauren (MU 2018*); Nowak, Carolynn E. (Mu 2018); Bonser, Steven M.**
Department of Chemistry, Millersville University, Millersville, PA 17551

Diaziridines are three-membered rings made up of two nitrogen atoms and one carbon atom. These rings could give rise to some novel pharmaceuticals *via* the less explored pathway of N-N bond cleavage of the three-membered diaziridine ring. The anticipated compounds are 1,3,4-Oxadizolines and/or Amidines that will be achieved with treatment of either heat or base. For this project, the synthesis, purification, and characterization of these new compounds using electron-donating substituent groups on the reactant diaziridines will be completed in a continuation of a previous student's research. Additionally, the study of the effect of electron-withdrawing substituent groups bound to the diaziridine rings will also be explored.

4. The Synthesis and Study of Aurones: A Class of Compounds with Emerging Biological Potential

*Strempel, Cole H. and Bonser, Steven M.**
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Aurones are an important class of heterocyclic natural products in the flavonoid family that provides the bright yellow color to several types of plants. The natural aurones and their synthetic derivatives possess a wide array of biological properties, such as anticancer, antioxidant, antidiabetic, anti-inflammatory, antibacterial, and antifungal. We hope to synthesize aurones that possess a wide spectrum of substituents in order to study their optical-electronic effects on the pharmacological activity of the aurone system.

* faculty mentor

Chemistry

5. The Synthesis and Physical Organic Study of Thioaurones

*Caceci, Peter F. and Bonser, Steven M.**
Department of Chemistry, Millersville University, Millersville, PA 17551

Thioaurones are the sulfur analogues of aurones and they have enjoyed a wide range of applications: they are used in the dyes and cosmetics fields, and as photoswitchable materials in electrophotography, but have also been reported to be cytotoxic to cancer cells. Unlike aurones, their biological properties have not been thoroughly investigated. While it is interesting to speculate on whether or not thioaurones could also be employed as fluorescent probes in medical imaging applications, it is their potential application as photoswitches that is interesting to us. We are attempting to synthesize a series of thioaurone derivatives in order to understand the effect various substituents may have on the spectroscopic properties of the conjugated donor-acceptor chromophore system.

6. The Physical Organic Study of Ring Strain on Yellow Dye Containing Couplers

*Fernandez, Froylan O. (MU 2019) and Bonser, Steven M.**
Department of Chemistry, Millersville University, Millersville, PA 17551

In order to better understand the effects of conformational torsion on the absorption properties of certain yellow dye chromophores, we plan to do a physical organic study of certain bicyclic amino-ketone derivatives, by utilizing a methodology known as the Quantitative Structure/Activity Relationship (QSAR) process. By changing the ring size of the bicyclic amino-ketone portion of the yellow dye molecule from a 4-membered ring (n = 2) to an 8-membered ring (n = 6), the electronic properties of the yellow chromophore should dramatically change due to the conformational restraints of the fused-bicyclic system. We will start by developing a synthesis for the bicyclic amino-ketones where n = 3 and 4.

*faculty mentor

Chemistry

7. Progress Towards the Synthesis and Chemistry of 2-Sulfobenzoyldiaziridines

*Mitzel, Cale T. (MU 2018) and Bonser, Steven M.**
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Diaziridines are a class of three-membered ring heterocycles that contain one carbon and two nitrogen atoms. They are useful intermediates in the synthesis of more complex heterocyclic compounds, some of which have found applications in the pharmaceutical industry. Although several studies on the synthesis and chemistry of 1,2-diaroyldiaziridines have appeared in the chemical Literature, there are no reports on their ***2-sulfobenzoyl*** analogues. The purpose of this Poster is to present the progress towards the synthesis of some novel 2-sulfobenzoyldiaziridine derivatives in order to study their chemical reactivity.

8. *Ab Initio* Molecular Orbital Theory

*Richard Carr, Michael S. Elioff**
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Computational studies of sulfur- and phosphorous-containing high energy density materials (HEDMs) were performed in order to assess energetic parameters such as gas-phase heats of formation of these substances. The molecules were modeled using Spartan and Gaussian software with both Hartree-Fock and Density Functional Theory using correlation-consistent basis sets such as aug-cc-PVTZ. The calculated enthalpies were compared to experimental data. Results so far have yielded distinct patterns. For example, molecules with intense ring strain are better modeled using Hartree-Fock. These differences are analyzed in the context of computational methodology.

*faculty mentor

Chemistry

9. Studies Toward 3,4-Dihydro-2(H)-Quinolinone Derivatives

*Ou, Yongyu (Rose); Whitcraft, Isaac; Kennedy, Steven**
Department of Chemistry, Millersville University of Pennsylvania, Millersville, PA 17551

Hunanamycin A (HA) is a natural product isolated from Bacillus hunanensis; it was discovered by MacMillan et al. while investigating sediment from mangrove swamps in the Bahamas. HA exhibits antibacterial activity against various Gram-negative pathogens such as Salmonella and Escherichia coli. Demand for antibacterial compounds is increasing as bacteria become more resistant to available antibiotics. Nevertheless, only an extremely small amount of HA (ca. 10 mg) can be isolated from a large number of bacteria, not enough for future biological studies. To further explore HA and structurally related compounds, chemical synthesis from readily available starting materials is underway. Our project aims to optimize the synthesis of 3,4-Dihydro-2(1H)-quinolinone derivatives. We have synthesized 2-bromo-4,5-dimethylaniline—our starting material—from 3,4-dimethylaniline, in 33% yield over three steps. We are currently using 2-bromoaniline as a model system to study amide formation followed by Lewis acid catalyzed cyclization as a method to access the 3,4-Dihydro-4,4-dimethyl-2(1H)-quinolinone core structure.

10. Synthesis of 1,2-Dihydronaphthalenes and Indenes for Substrate Scope and Limitation Studies of Substituted Cyclobutane Formation via Photoredox Catalysis

*Chanveboll Yun, Steven M. Kennedy**
Department of Chemistry, Millersville University, Millersville, PA 17551

Photoredox catalysis (PRC) provides efficient access of highly substituted cyclobutane rings via [2+2] photocycloadditions. Substituted cyclobutanes are a prevalent structural motif of many biological active natural products; they often exhibit antiviral, anticancer, or antifungal related properties. We have initiated studies to explore and expand the scope and limitations of Ruthenium PRC as a means to access cyclobutanes containing substituents arising from substituted 1,2-dihydronaphthalene or indene precursors. Building on the work of Chen et al., $Ru(bpy)_3^{2+}$ and $Ru(bpm)_3^{2+}$ will be initially screened against a small library of olefins, which can be synthesized in two steps from a variety of commercially available tetralones or 1-indanones. The library will be partially produced by an upper-level advanced organic chemistry laboratory class utilizing a Course-Based Undergraduate Research (CURE) process to produce starting material olefins and preliminary catalysis data.

*faculty mentor

Earth Sciences

11. Seasonal Phytoplankton Production at the New England Shelf Break Front: Observations Using the Coastal Pioneer Array's Submarine Gliders

*Kyle Ehmann, Samantha Ferguson, Cassandra Alexander (YOG 2019), and Robert D. Vaillancourt**
Ocean Sciences and Coastal Studies Program, Earth Sciences Department, Millersville University, Millersville, PA

The New England shelf break front is a biologically productive ocean region and an important commercial fishing site. Sustained observations at this site have been difficult until recently. The Ocean Observatories Initiative's Pioneer Array is a series of platforms and sensor systems deployed at this frontal site and is used to measure ocean properties and processes year around. We used the Pioneer Array's fleet of autonomous gliders to observe the seasonal changes at the shelf break front. Our preliminary results show a spring-time enhancement of primary production, as accumulated chlorophyll a, at the ocean's surface associated with density surfaces along which upwelling has previously been observed.

12. Radiation Profiles During a Quiescent Sun

*Rhiannon Fleming, Sam Carlson, Samuel Reams, Noah Stitely, Richard Clark**
Department of Earth Science, Millersville University, Millersville, PA 17551

Vertical profiles of high energy radiation will be investigated during a period of quiescent, calm, sun. New and previously obtained vertical profiles acquired during solar minimum, were the sun is at lowest activity, will be studied in order to document the structure of the radiation. Data will be collected during high altitude balloon ascents, routinely attaining altitudes of 35,000 meters, with onboard radiation probes and meteorological sensors. The balloon carries a payload containing a data storage device and three probes, two measuring bandwidths of ultraviolet radiation, UVA and UVB, and the third measuring X-ray and gamma radiation. Once the radiation package is retrieved, the data from the device is downloaded and processed through a program to be studied and interpreted. Primarily, the research is conducted to understand radiation profiles over southeastern Pennsylvania while also developing research, data processing, and professional presentation skills in students.

*faculty mentor

Earth Sciences

13. Relationship Between High Energy Actinic Flux and Particle Number Density

*Patrick Roelant, Anthony Iampietro, Gabriela Himmele, Dr. Richard Clark**
Department of Earth Sciences, Millersville University, Millersville, PA 17551

The primary purpose of this experiment is to study the relation of actinic flux of gamma, x-ray, UVA, and UVB radiation to the density of dry air in the upper atmosphere. The purpose of this experiment was to calculate the density of dry air in the upper atmosphere (200 mb+) using the dry air equation and scale height to compare findings with the actinic flux. The resulting equation allows for comparison between the data that was obtained by launching a high altitude weather balloon with a high energy radiation sensor onboard, which also defines the relation of actinic flux to upper atmosphere. The graphed difference of air density to amount of radiation will articulate how accurate the equation is in its predictions of high energy radiation is with the density of dry air. Finding a relationship between radiation flux and upper air density will potentially help future predictions pertaining to high altitude high energy.

*faculty mentor

Physics

14. X-ray Analysis of Large Magellanic Cloud Supernova Remnant 0548-70.4

*Lucas Staub and Sean P. Hendrick**
Department of Physics, Millersville University, Millersville, PA 17551

There are two known causes of a supernova (SN) explosion; a thermonuclear detonation of a white dwarf (Type Ia), and a gravitational core collapse of a massive star (Type Ib/c and II). A shockwave is created in the core as stars explode. The shockwave travels through the rest of the star providing the energy needed to synthesize the elements of the periodic table, beyond the iron the stars create during their life-cycle. The shockwave continues to expand into the interstellar medium (ISM), sweeping up material around the star. A supernova remnant forms in the wake of the shockwave and is comprised of swept-up material from the ISM, and emission from the newly synthesized material in the SN ejecta. This project focuses on X-ray analysis of the supernova remnant (SNR) 0548-70.4 using archival data from the *Chandra* X-ray Observatory. *Chandra*'s high angular and spectral resolution allows us to perform spatially-resolved spectroscopy. We can separate our target into several regions to examine the spectra of each. SNR 0548-70.4 has been separated into several regions. The limbs of the remnant show emission from the ISM material swept-up, and heated to X-ray temperatures, by the shockwave; while the center of the remnant contains the SN ejecta. The swept-up ISM material is also present in the background and foreground of this central region. The *Sedov* solution was designed for a point explosion in a uniform density region, and can be applied to the limb regions. The model has allowed us to determine a shock speed of 1.28×10^6 m/s and an age of 3,990 years. For the central region, we will use a two-component model: the best Sedov fit to the limbs, and an additional model for the SN ejecta. These results will determine the chemical abundances in the ejecta and help to determine the type of explosion that took place, helping to increase our understanding of stellar evolution and the life cycle of stars.

*faculty mentor

Physics

15. Resistivity of Silver Thin Films

*Ken Brubaker and Tariq Gilani**
Department of Physics, Millersville University, PA 17551

The purpose of this research is to investigate the electrical properties of Silver Thin Film (TF). The focus will be on the conductivity as a function of thickness of the Silver TF. The TFs are Several samples of Silver TFs of various thicknesses ranging from 5 nm to few μm were made using thermal evaporation of 99.999% pure Silver on glass substrate. The electrical resistivity was measured using 4-probe method. The results of electrical resistivity vs thickness of the Silver TF are presented here. The resistivity depends on thickness of the film when thickness becomes smaller than the mean free path of conduction electrons resulting in anisotropic scattering. The surface roughness of the TF also plays an important role in determining the scattering of conduction electrons. Therefore, it is important to examine the surface of the TFs under a scanning electron microscope, which is under progress.

*faculty mentor

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An asterisk (*) denotes the SCTE faculty mentor for the student research