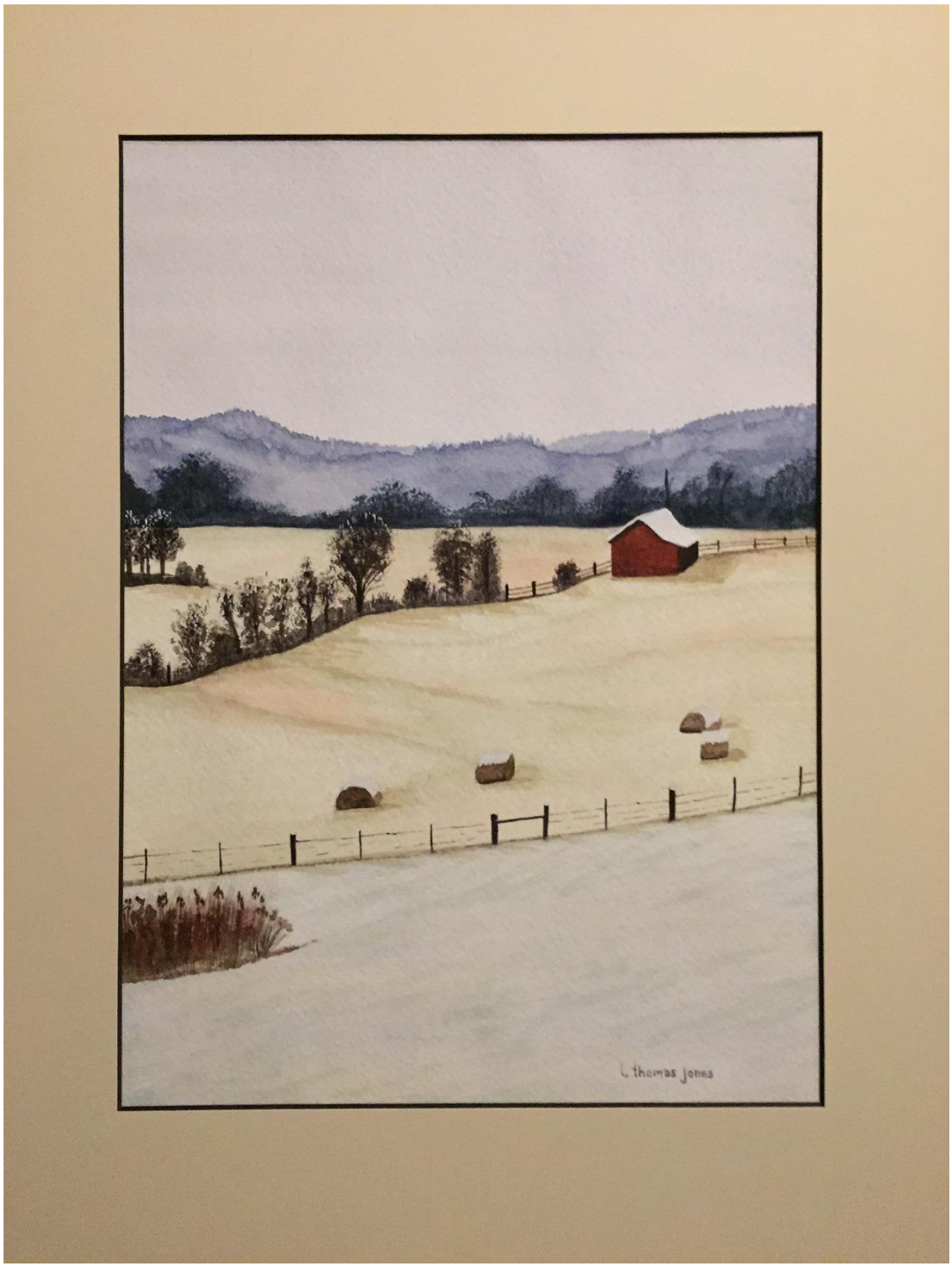

Berea College Undergraduate Abstract Journal 2016

INTRODUCTION

Editors: Marah Zeidan (Junior Biology Major); Ronald B. Rosen (Professor of Biology)

This eleventh (2016) issue of the "Berea College Undergraduate Research Abstract Journal" contains 59 different abstracts representing majors from 9 different academic programs. Thirty-two (54.2%) of these abstracts represent research conducted on-campus with Berea College Faculty mentors. The common theme to the research presented in these abstracts is that the: (1) original proposal was peer-reviewed and/or (2) work was subsequently presented by undergraduates at on and/or off-campus meetings. Several projects were funded by academic programs; most (N=31) on-campus research was made possible with funds provided by Berea College's Undergraduate Research and Creative Projects Program (URCPP). Off-campus projects were funded by academic institutions throughout the country often with assistance from Berea College's Office of Internships. Many of these projects were presented on-campus during the 16th Berea Undergraduate Research Symposium (BURS) on October 7, 2016. Most of these projects were subsequently presented at the 102nd Annual Meeting of the Kentucky Academy of Science at the University of Louisville (49 presentations and 24 awards). If known, presentations, awards received and funding sources are noted below each abstract. Images of student participants are included if available.

ACKNOWLEDGEMENTS

This publication would not have been possible without the support of many people. We would like to thank Chad Berry, Academic Vice President and Dean of the Faculty, for providing funds to print hard copies of these abstracts, Esther Livingston for arranging funding from the Berea College CTL Internship Program and Sarah Broomfield and Martin Veillette for coordinating the URCPP initiative on campus. Gratitude is extended to Berea College faculty for their mentorship, and of course to students whose exemplary work is reflected in this journal. Additionally we would like to acknowledge Lisa Thomas Jones (Mathematics Major - Class of 1983), for the original cover art. Finally, we would like to thank all the off-campus mentors at the following institutions for supporting Berea students during the summer of 2016 (number of Berea students in brackets): Bard College {1}, Harvard University {1}, Jefferson Lab {1}, Mayo Clinic {2}, Ohio State University {1}, Scripps Research Institute {1}, University of Colorado, Denver {2}, University of Kentucky {4}, University of Louisville {2}, University of Miami {1}, University of Pittsburgh {1}, University of Tennessee {1}, University of Wisconsin {1}, and Vanderbilt University {7}. Special thanks to Berea alumni including Dr. Dennis Roop (University of Colorado, Denver) and Rocky Tuan (University of Pittsburgh), and Vanderbilt University faculty Julie Hudson, Billy Hudson and Roy Zent for facilitating research opportunities at their respective institutions for Berea College students. We continue to be deeply indebted to Berea College alumnus, Dr. Hal Moses, who was instrumental in establishing our valued relationship with Vanderbilt University.

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Appendix

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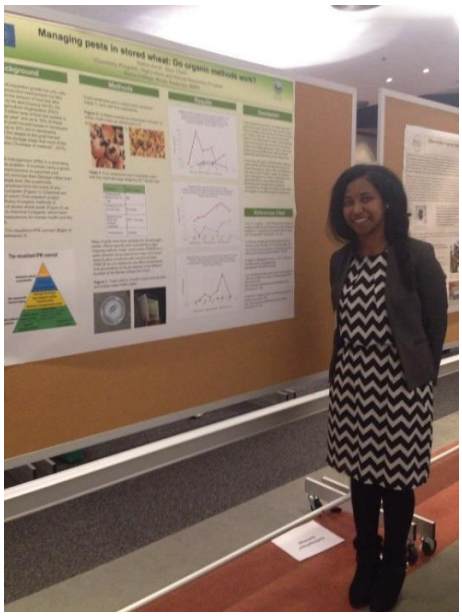
Managing Pests in Stored Wheat: Do Organic Methods Work? Helina Asrat and Sean Clark**.** Agriculture and Natural Resources Program, Berea College, Berea, Kentucky, 40404.

Protecting cereal grains from post-harvest storage losses is fundamental to the sustainability of any food system. The conventional practice of using chemical fumigants results in undesirable side effects to human health and the environment. Organic agriculture is premised on minimizing those negative effects but questions remain about the efficacy of nonchemical methods. In this study we evaluated the effectiveness of diatomaceous earth and freezing in suppressing pests of stored wheat, *Triticum aestivum* L., in a USDA-certified organic grain supply chain. Three treatments were compared to an untreated control: 1) diatomaceous earth mixed in with the grain prior to bagging; 2) a freezing period after bagging; and 3) a combination of the two practices. There were five replicated bags (22.7 kg or 50 lbs) of each treatment stored at ambient temperature in a grain storage facility. The wheat was monitored to measure infestation levels of adult maize weevils, *Sitophilus zeamais* Motschulsky. In addition, the relative population levels of maize weevil and Indian meal moths, *Plodia interpunctella* (Hübner), were monitored using pheromone- and kairomone-baited traps in the same storage facility, as well as in the cleaning facility that preceded it and the bakery that followed in the supply chain. All three treatments were found to suppress maize weevil levels relative to the untreated control though none completely eliminated the pest. The numbers of maize weevil and Indian meal moths found in the traps decreased with each successive stage in the supply chain to negligible levels in the bakery.

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Poster Presentation)

102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Poster Presentation- Agricultural Sciences: 1st Place Undergraduate Research Competition)

Funded by Berea College Office of Internships and Berea College Farm



Effect of Hive Type on Cell Size and Varroa Mites, *Varroa destructor* (Anderson and Trueman), in Honey Bee (*Apis mellifera* L.) Colonies. Kassandra H. Carter and Sean Clark. Agriculture and Natural Resources Program, Berea College, Berea, Kentucky, 40404.

Varroa mite, *Varroa destructor* (Anderson and Trueman), is among the most important pests of honey bees, *Apis mellifera* L., resulting in substantial colony losses despite miticide treatments. There is some anecdotal information from the beekeeping community that honey bees in top-bar hives will build comb with smaller cells compared to standard Langstroth hives and that this smaller cell volume results in a reduction in varroa mite infestations. To test this claim, 38 hives in Berea, Kentucky, managed by 13 different beekeepers were included in a comparison of cell size and varroa mite levels between the two hive types. Hives were examined once or twice for a total of 49 and 52 measurements for varroa mites and cell size, respectively. Varroa mite levels were assessed using the sugar roll method with worker bees taken from the brood area. Cell size was measured with a digital caliper. Mean cell diameter in the comb of top-bar hives was 0.25 mm less than that of the Langstroth hives ($P < 0.00001$). Mean varroa mite levels on adult worker bees in top-bar hives were also found to be less than those of the Langstroth hives ($P < 0.05$). The findings lend support to the claims that the use of top-bar hives may be a means of suppressing varroa mites. These conclusions should be taken with caution, however, since all of the Langstroth hives were located at one site (Berea College Farm) and colony age was not taken into consideration.

Berea Urban Farm Backyard Beekeeping Workshop, July, 2016, Berea, Kentucky (Oral Presentation)

Agriculture and Natural Resources Research Poster Synopsis, October 27, 2016, Berea College, Berea, Kentucky (Poster Presentation)

102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Poster Presentation- Agricultural Sciences: 2nd Place Undergraduate Research Competition)

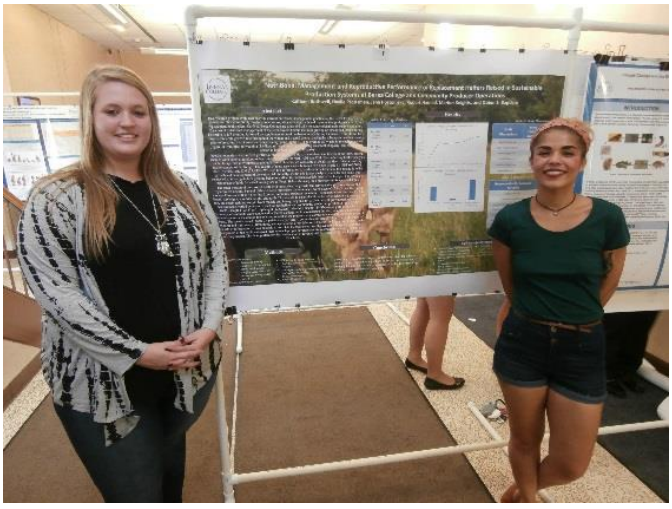
Funded by Berea College Office of Internships and Berea College Farm

Nutritional Management and Reproductive Performance of Beef Heifers Raised in Sustainable Production Systems at Berea College and Community Producer Operations. Haylie Prottsman, Kaitynn Rothwell and Quinn Baptiste. Agriculture and Natural Resources Program, Berea College, Berea, Kentucky, 40404.

This project evaluated the nutritional management and reproductive performance of beef heifers raised in sustainable production systems at Berea College and community producer operations. The project used the replacement heifer herd at the Berea College Farm and accessed other production herds in the wider Berea College Community. Specifically, in this, the first year of this multiyear project, the research efforts determined that there was variable feeding of supplemental grain as a component of the nutritional management for replacement heifers. The variation in nutritional management approaches affected heifer growth and development, particularly during the winter period, when apparently lower rates of growth occurred in heifers that are strictly grass fed. Despite the latter variation the results indicate that onset of reproductive maturity and potentially reproductive performance of heifers raised in sustainable production systems at Berea College Farm were similar to what was obtained at community producer operations. The occurrence of rapid rates of growth in heifers during the spring period in grass fed heifers is believed to have compensated for lower rates of gain that occurred during winter, and contributed to the absence of differences in reproductive performance between grain supplemented and strictly grass fed heifers. These rapid rates of growth observed in grass fed heifers are perceivably attributable to the rotational grazing management strategy that was used for feeding of strictly grass fed heifers during the spring period. The apparent changes in forage composition, nutrient content (fiber and protein) and digestibility during the spring period and within a grazing rotation were perceivably critical to the success of nutritional management strategies. Hence, initial results are promising and indicate the need for continued investigations into the sustainable management approaches used at Berea College Farm and community producer operations for developing replacement heifers.

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Poster Presentation)

Funded by Berea College URCPP



Implementation of Digital Fabrication Technologies in Ceramic Practice. Ashley Aiken, Victoria Slaughter and Raymond Gonzalez. Art and Art History Program, Berea College, Berea, Kentucky, 40404.

Pushing beyond traditional methods of ceramic production, our goals were to explore the lines between digital fabrication and ceramics. Beginning with vinyl cut and rapid prototyped objects we explored the various potentials of incorporation with the ceramic medium. Further exploration led to the construction of a 3D printer that prints objects with clay. The conclusion of the project involved introductory exercises exploring capabilities of the 3D ceramic printer. Overall success of the project could be seen through students' reflection, creative outcomes, and a deeper understanding of the marriage of ceramics and technology.

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Poster Presentation)

Funded by Berea College URCPP

Spreading Knowledge of the Berea College Art Collection to the Larger Community. Susan Bonta, Constantine Botimer and Meghan Doherty. Art and Art History Program, Berea College, Berea, Kentucky, 40404.

With over 14,000 objects, the Berea College Art Collection is an undervalued resource for teaching across the curriculum. This project aimed to increase visibility of the Collection, both on campus and off, by creating a website with high-quality content related to a selection of 100 objects. Working together, two students and Professor Doherty wrote statements about each object. Although they are brief, these statements provide visitors to the site who are unfamiliar with the range and depth of the Collection in-roads to aid them in using the Collection for their teaching and research. The materials we wrote are available now on our newly, re-designed website: http:// dulmanngalleries.berea.edu/collections/objects/

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Poster Presentation)

Funded by Berea College URCPP

A Metaphorical Staircase. Eddie Henderson, Charity Ryan and Daniel Feinberg. Art and Art History Program, Berea College, Berea, Kentucky, 40404.

Without Metaphor is a sculptural-performance project that heavily considers our reliance on using metaphor when understanding both the physical world as well as abstract concepts, such as love and time. The project creates a parallel between our usage of metaphor and a history of human exploitation of certain concepts such as our natural resources. At best, we might have a heightened respect for the world around us that we rely on for survival, not wanting to exploit it but care for it as it cares for us. But this attitude towards the earth has not endured, particularly in Western society. Instead, we have a long narrative consisting of humans attempting to dominate and control the world, often under the assumption that through our own scientific and technological development, we are not limited by what the world has to offer. We ask: why would our usage of metaphor be any different? For the project, we will be constructing a reproduction of the 22-foot tall Loretto Chapel spiral staircase, located in Santa Fe, New Mexico. Throughout the entire construction process, the builders will try to eliminate their metaphorical usage or limit it as much as possible. While the staircase has a storied history related to the progressive ideals of the Sister's of Loretto, the narrative takes a backseat to its more "miraculous" feats such as allegedly defying the laws of physics and being built by St. Joseph himself--traits that have redefined the staircase as a tourist attraction and have overshadowed the rich history of the Sisters of Loretto. Just as we propose that our use of metaphor might not be utilitarian, but actually be an exercise of manipulating what is around us, the staircase has a similar narrative. The staircase was quickly repositioned from being something utilitarian to a symbol of dominance over the laws of physics and a capitalistic enterprise. We will visually connect these concepts through the eventual completion of a film of the recorded experience constructing the staircase *without metaphor*.

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Poster Presentation)

Funded by Berea College URCPP

Analysis of Neuromasts in *pkd2* Mutant Zebrafish. Hanna Abe[1] and Dr. Caroline Sussman[2]. [1]Berea College, Berea, Kentucky, 40404. [2]Mayo Clinic, Rochester, Minnesota, 55905.

Autosomal dominant polycystic kidney disease (ADPKD) is a genetic disease that causes the development and enlargement of fluid filled cysts in the kidney. It is the fourth leading cause of kidney failure and affects 1 in 400 to 1 in 1000 people. It is caused by mutations in *PKD1* and *PKD2* genes that encode PC1 and PC2. Previous studies have shown that PC2 is involved in renal epithelial cell proliferation. By analyzing a set of sensory organs, called neuromasts, which form the lateral line of the zebrafish, our studies have also suggested that PC2 affects cilia formation in neuromasts. Here, we used *Pkd2* mutant zebrafish embryos to analyze neuromast development. Fluorescent dyes, YO-PRO-1, DASPEI, and FM 1-43 were used to stain neuromast cells by entering mechano-transduction channels of developing neuromasts. Numbers of neuromasts, cells, and staining intensity were quantified in *pkd2* mutants and wild types. Additionally, we analyzed cell proliferation in *pkd2* mutant zebrafish. By using BrdU, a thymidine analog that incorporates into the DNA of dividing cells, we assessed cell proliferation in the neuromasts of the *pkd2* mutant zebrafish. Our results show that the number of neuromasts determined using DASPEI, YO-PRO-1, or DAPI staining, was lower in *pkd2* mutants at 3 dpf. DASPEI staining showed that the average number of cells/neuromast was higher in *pkd2* mutants at 4 dpf. Similarly YO-PRO-1 staining showed a higher number of cells/neuromast in *pkd2*mutants at 5 dpf. These data suggest PC2 affects neuromast development, possibly by regulating cell proliferation.

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Poster Presentation)

102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Oral Presentation)

American Society of Nephrology, November 14th, 2016, McCormick Palace, Chicago, Illinois (Poster Presentation)

Funded by Mayo nuSURF Program and Bonner Scholars Program, Berea College

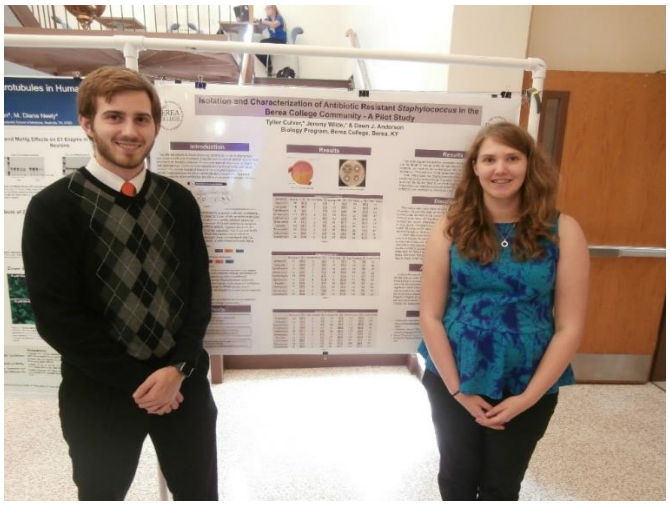
Isolation and Characterization of Antibiotic-Resistant *Staphylococcus* in the Berea College Community – a Pilot Study. Tyller Culver, Jeremy Wilde and Dawn J. Anderson. Biology Program, Berea College, Berea, Kentucky, 40404.

Bacteria of the genus *Staphylococcus* comprise part of normal human bacterial flora. Some *Staphylococcus* strains, such as *S. epidermidis*, are part of our permanent normal skin flora, while others, such as *S. aureus*, can be part of either the permanent or transient normal flora. *Staphylococcus aureus* can also be an opportunistic pathogen and may cause localized skin infections (e.g. abscess, impetigo), systemic infections (e.g. food poisoning) or other more serious infections (e.g. pneumonia, myocarditis). Pervasive overuse and inappropriate use of antibiotics have resulted in many *Staphylococcus* species, including *S. aureus*, becoming resistant to a wide variety of antibiotic drugs. Methicillin-resistant *Staphylococcus aureus* (MRSA) are a prime example. Historically, the primary risk for being exposed to MRSA strains was in hospitals or clinics, however, an increasing risk has developed from community-acquired MRSA (CA-MRSA) strains. The goal of this pilot study was to investigate the prevalence and level of antibiotic-resistant *Staphylococcus* within the Berea College (Berea, KY) community.

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Poster Presentation)

102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Poster Presentation- Microbiology)

Funded by Berea College URCPP



Expression of Discoidin Domain Receptor 2 in Human Embryonic Kidney Cells. Amber Follin[1], Corina Borza[2] and Ambra Pozzi[2]. [1]Biology Program, Berea College, Berea, Kentucky, 40404. [2]Vanderbilt University School of Medicine, Nashville, Tennessee, 37232.

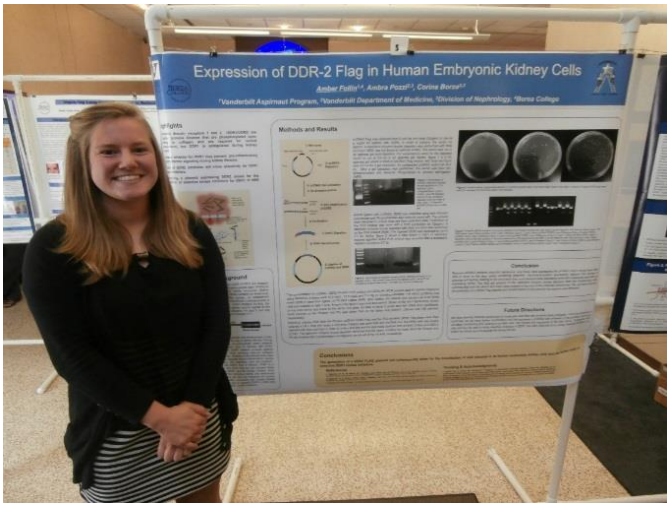
Discoidin domain receptors 1 and 2 (DDR1/DDR2) are receptor tyrosine kinases (RTKs) that become phosphorylated upon binding to collagen. DDR1 is required for normal development, but abnormal expression or activation of DDR1 may contribute to various diseases including cancer, atherosclerosis, and lung and kidney fibrosis. Studies with DDR1 knockout mice have shown that DDR1 deletion protects against glomerular injury, reduced collagen deposition, and reduced proteinuria. Studies at the cellular level have shown that DDR1 activation can regulate cell spreading, differentiation, migration, and invasion. Because of the detrimental role DDR1 has in fibrosis, we believe it is a viable target for therapeutics. By using a DDR1 specific kinase inhibitor, we can prevent the signaling by DDR1. Such inhibitors may target other RTKs, including DDR2 with detrimental side effects. To prevent this, we proposed to screen the inhibitors on human embryonic kidney cells (HEK cells) expressing the closely related RTK DDR2. The purpose of this initial study was to express DDR2 in HEK cells. The following techniques were used: bacterial culture, double restriction enzyme digestion, plasmid DNA isolation (mini-prep), DNA gel-purification, DNA EtOH precipitation, PCR amplification, purification, and T4 DNA ligation. The generation of a FLAG-DDR2 plasmid and transformation of this plasmid into bacteria was achieved. Sequencing of minipreps further confirmed our success, and we foresee transfecting HEK cells with this plasmid in the near future.

KUKUH Summer Undergraduate Research Conference, August 6th- 8th, 2016, Mayo Clinic, Rochester, Minnesota (Poster Presentation)

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Poster Presentation)

102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Poster Presentation- Cellular & Molecular Biology)

Funded by Berea College Office of Internships and Hal Moses/Aspirnaut Research Internship, Vanderbilt University



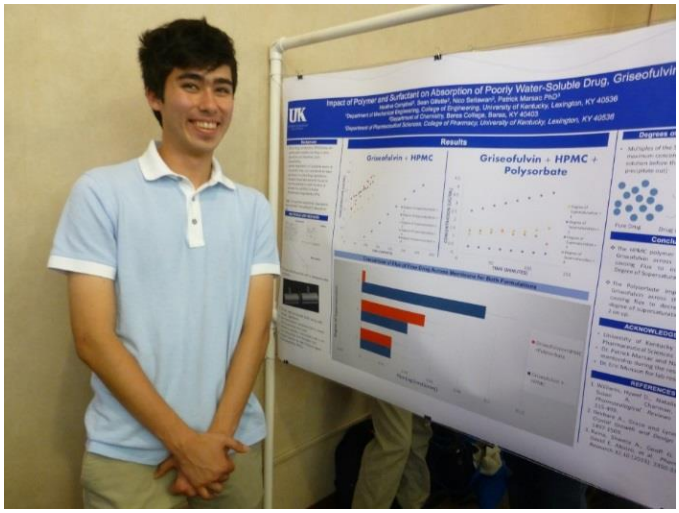
Impact of Polymer and Surfactant on Absorption of Poorly Water-Soluble Drug, Griseofulvin. Sean Gillette[1] and Patrick Marsac[2]. [1]Biology Program, Berea College, Berea, Kentucky, 40404. [2]University of Kentucky, Lexington, Kentucky, 40506.

Griseofulvin is a commonly used antifungal drug on the market. The drug is used in the treatment of well-known infections like ringworm and athlete's foot. Polysorbate and HPMC polymer are compounds that are used quite often in the drug industry to increase the solubility of drugs in solution in the gastrointestinal tract. Those two compounds have been used as staple inactive ingredients in drug formulations in terms of increasing the bioavailability of drugs. But a current area of research on drug formulations, and the focus of this research, has been the impact that inactive ingredients (like Polysorbate/HPMC) have on the absorption of pure drug across the gastrointestinal membrane for uptake into the bloodstream. An experimental setup composed of two chambers separated from one another via a synthetic membrane was put together and used to test the effect of Polysorbate and HPMC polymer on Griseofulvin absorption across a synthetic membrane. HPMC polymer was found to have caused a linear increase in drug absorption across the synthetic membrane. Polysorbate was found to have caused a linear decrease in drug absorption across the synthetic membrane after a certain concentration of pure drug in solution was reached.

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Poster Presentation)

102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Poster Presentation- Chemistry: Organic/Inorganic)

Funded by Berea College Office of Internships



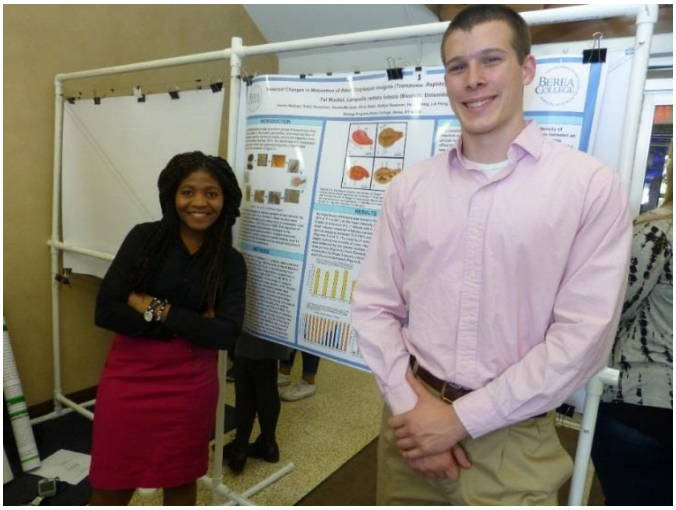
Seasonal Changes in Maturation of Adult *Cotylaspis insignis* (Trematoda: Aspidogastridae) Recovered from the Fat Mucket, *Lampsilis radiata luteola* (Bivalvia: Unionidae). Robin Hauschner, Favour Akabogu, Nina Meneses, Olivia Slater, Kaitlyn Reasoner, Hsuan Peng, Lin Peng, Chi Peng and Ron Rosen. Biology Program, Berea College, Berea, Kentucky, 40404.

The objective of this study was to assess seasonal changes in the maturation of young and mature adult *Cotylaspis insignis* recovered from the gill/visceral mass junction of the fat mucket, *Lampsilas radiata, luteola*, over 14 months. Mussels were collected from North Elkhorn Creek, Scott County, Kentucky, U.S.A., between May 2015—July 2016. Staging of *C. insignis* (N = 675 worms) was based on the following criteria: Stage 1 = 17—18 peripheral alveoli in ventral sucker and 8 medial alveoli; Stage 2 = 19—20 peripheral alveoli in ventral sucker and 9 medial alveoli; Stage 3 = developing vitellaria present; Stage 4 = eggs present. Seasonal changes in the proportions of these stages were apparent in this study. Recruitment of a new cohort of adult worms by mussels began by December as evidenced by an increasing proportion of Stage 2 worms; this increase coincided with a steady decrease/loss of the older cohort of Stage 4 worms between November and March. By March and April, developing vitellaria (i.e., Stage 3 worms) became obvious in many *C. insignis*, and the majority of worms in this new cohort began to engage in egg production (Stage 4 worms) by late May/early June.

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Poster Presentation)

102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Poster Presentation-Zoology: 2nd place Undergraduate Research Competition)

Funded by Berea College URCPP



Examination of Species Richness and Diversity of Mosquitoes on the Campus of Berea College.
Jillian Kendall[1], Robin Hauschner[1], Kenneth Blank[2] and Sarah Blank[1]. [1]Biology Program, Berea College, Berea, Kentucky, 40404. [2]Eastern Kentucky University, Richmond, Kentucky, 40475.

Mosquitoes vector human pathogens that kill three quarters of a million people each year worldwide. There is limited literature regarding species richness and diversity of Kentucky mosquitoes. The goal of this project was to determine the relative abundance and diversity of mosquito species on the campus of Berea College located in southern Madison County, KY. Three different trap types (CDC Miniature Light Trap, BG-Sentinel Trap, and a Gravid Trap) with octanol, skin extract, CO_2 and/or grass infused water attractants were used to collect mosquitoes at four sites each week for a total of eight weeks (June 15 – August 9). Traps were set between 4pm and 6pm each afternoon and retrieved between 8am and 10am the next morning. A total of 1,646 mosquitoes were collected representing six genera and 20 species. The top five most abundant species were *Culex pipiens* (30.7%), *Aedes albopictus* (17.8%), *Aedes vexans* (16.5%), *Culex salinarius* (6.6%), and *Psorophora columbiae* (4.3%). *Aedes albopictus, Culex pipiens, and Anopheles punctipennis* were the most abundant species at Sites 1 and 4, where there was the most human traffic. The greatest number of mosquitoes was collected from the compost area (Site 2; n=750), while the greatest species diversity was found at the College farm (Site 3). *Aedes aurifer*, a species never found further south than southern Ohio, was identified for the first time in Kentucky at two of the collection sites.

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Oral Presentation)

102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Oral Presentation- Zoology: 2nd Place Undergraduate Research Competition)

Funded by Berea College URCPP

Development of Therapeutics for Sleep Apnea Targeting Kir2.4 Potassium Channels. Meghan E. Kramer[1], Eric E. Figueroa[2], Sujay V. Kharade[2] and Jerod S. Denton[2]. [1]Biology Program, Berea College, Berea, Kentucky, 40404. [2]Vanderbilt University School of Medicine, Nashville, Tennessee, 37232.

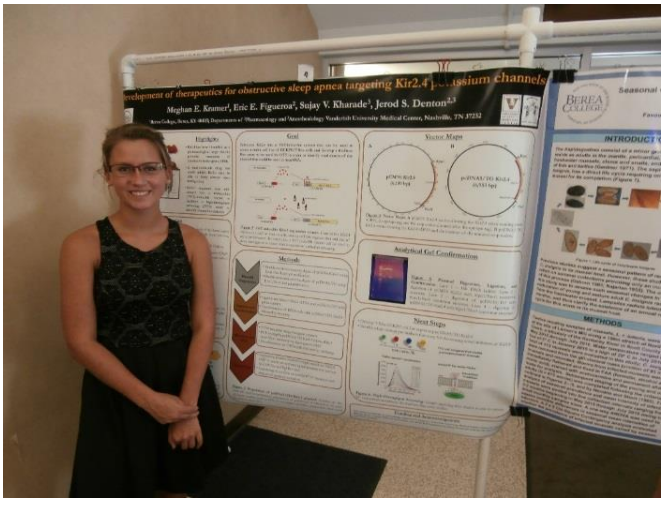
More than 18 million Americans have obstructive sleep apnea (OSA). The NIH recommends the use of a continuous positive airway pressure (CPAP) machine to keep airways open during sleep. However, only about half of OSA patients use a CPAP device as prescribed due to feelings of claustrophobia, facial irritations, and general discomfort. Consequently, there is a critical need for the development of pharmacological therapeutics for OSA that keep the airway open during sleep. The inwardly rectifying potassium (Kir) channel Kir2.4 has recently emerged as a potential drug target for OSA. The overarching goal of this study is to develop a high-throughput screening (HTS) assay to support the development of drug-like inhibitors for evaluating the therapeutic potential and "druggability" of Kir2.4 for OSA. The specific purpose of this project was to sub-clone the open reading frame (ORF) of Kir2.4 into a plasmid vector for expressing Kir2.4 heterologously in a tetracycline-inducible manner. Standard molecular biology techniques were used to excise Kir2.4 ORF from pCMV6 using KpnI and NotI restriction sites and ligate it into the corresponding sites of pcDNA5/TO. Mutagenic PCR was used to introduce a stop codon at the 3' end of the Kir2.4 ORF to prevent expression of a C-terminal epitope tag. The Kir2.4 ORF with the introduced stop was successfully subcloned into pDNA5/TO. The development of a tetracycline-inducible Kir2.4 expression vector will enable the development of a HTS assay for discovering small-molecule inhibitors of Kir2.4.

KUKUH Summer Undergraduate Research Conference, August 6th- 8th, 2016, Mayo Clinic, Rochester, Minnesota (Poster Presentation)

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Poster Presentation)

102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Poster Presentation- Cellular & Molecular Biology: 3rd place Undergraduate Research Competition)

Funded by Berea College Office of Internships and Hal Moses/Aspirnaut Research Internship, Vanderbilt University



The Application of Glo1 CRISPR Cas-9 Knockout Cells for the Study of Neuropathy. James McCarthey[1], Jim Galligan[2], James Wepy[2], CC Lutz[2] and Lawrence Marnett[2]. [1]Biology Program, Berea College, Berea, Kentucky 40404. [2]Vanderbilt University School of Medicine, Nashville, Tennessee, 37232.

Methylglyoxal (MGO) is a potent glycating agent that is produced as a byproduct of glycolysis. This dicarbonyl reacts with proteins and nucleic acids to form advanced glycated end products (AGEs). MGO concentrations are held in check by glyoxalase 1 (Glo1), by converting MGO into S-D-lactoylglutathione at the expense of glutathione. The role of MGO in neuropathy is unclear; however the use of Glo1 CRISPR knockout cells may reveal its importance. Mouse neuroblastoma cells were transfected with CAS-9, a specific guide RNA targeting Glo1, and puromycin resistance. After screening for transfection using puromycin, recovered cells were separated into single cell colonies using flow cytometry. DNA was then extracted and PCR was performed to amplify regions of interest. To screen for knockout cells, restriction length polymorphism screening (RFLP) was conducted. RFLP revealed frameshift mutation, as lack of DNA cutting by endonucleases at sites disrupted by CAS-9 were visualized. Western Blot analysis results found that the Glo1 protein was not expressed in cells that were RFLP positive. Glo1 activity was also monitored, revealing no production of S-D-lactoylglutathione. The use of Glo1 CRIPSR knockout cells will be utilized to assess the role of methylglyoxal in the pathogenesis of neuropathy.

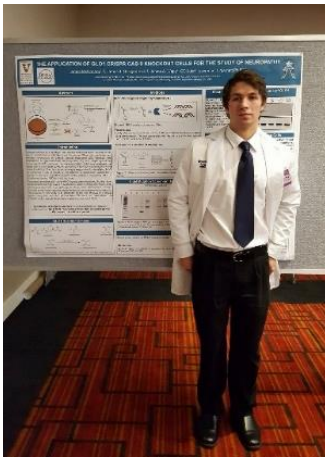
KUKUH Summer Undergraduate Research Conference, August 6th- 8th, 2016, Mayo Clinic, Rochester, Minnesota (Poster Presentation)

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Poster Presentation)

102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Poster Presentation- Physiology and Biochemistry: 2nd Place Undergraduate Research Competition)

American Society of Nephrology, November 14th, 2016, McCormick Palace, Chicago, Illinois (Poster Presentation)

Funded by Berea College Office of Internships and Hal Moses/Aspirnaut Research Internship, Vanderbilt University



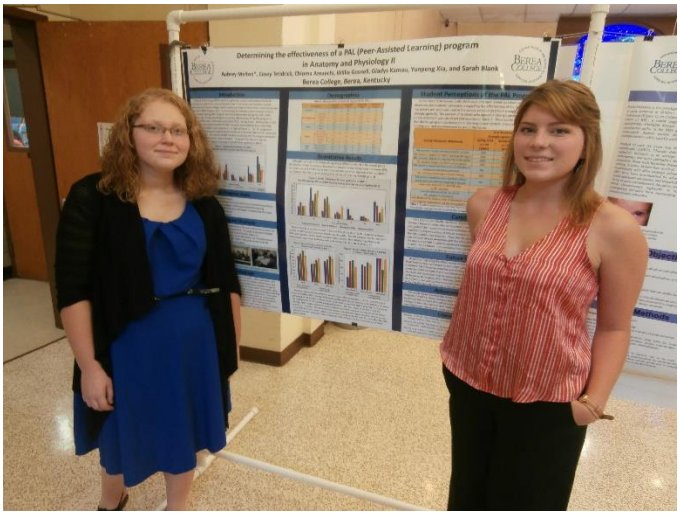
Examination of the Effectiveness of a Peer-Assisted Learning (PAL) Program Implemented in Anatomy and Physiology II. Aubrey Melton, Casey Tetidrick, Chioma Amaechi, Willie Gosnell, Gladys Kamau, Yunpeng Xia and Sarah Blank. Biology Program, Berea College, Berea, Kentucky, 40404.

Anatomy & Physiology (A&P) I and II are gateway courses populated by pre-nursing and health and human performance majors. Nationally and at Berea College, these courses have high attrition (≥40%). In order to increase student success, a three-year study tested the effectiveness of a Peer-Assisted Learning (PAL) program that was implemented in the A&P courses. Participation in the PAL program had positive benefits for A&P I students demonstrated by a statistically higher percent success (final grade ≥ C). The goal of this research was to determine if the PAL program continued to benefit these students in A&P II. In A&P II, students were required to co-register for a PAL course that met for 50 – 70 minutes once per week. Attendance, preparedness, and participation determined the PAL grade which made up 5% of the student's course grade. Analysis of quantitative data showed limited benefits to the majority of A&P II students. There was slightly higher student success in the years in which PAL was implemented, but the African American cohort was the only population that showed significantly higher success [33% success in Spring 2013 prior to PAL implementation compared to 82% (Spring 2014), 86% (Spring 2015) and 67% (Spring 2016)]. Analysis of student responses on post-term surveys revealed that the majority of students agreed that the PAL program helped them learn course content, encouraged critical thinking, and increased their confidence in asking questions during lecture. Students (68% – 85%) also recommended the use of the PAL program in the future.

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Poster Presentation)

102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Poster Presentation- Science Education: 1st Place Undergraduate Research Competition)

Funded by Berea College URCPP



Effect of Ziram and Methylmercury on Ubiquitin Activating Enzyme E1 and Microtubules in Human Neurons and Mouse Neuro2A Cells. Monica Moran[1], Iyana Gray[2], Kathleen Dennis[2], William Valentine[2], Aaron Bowman[2] and Diana Neely[2]. [1]Biology Program, Berea College, Berea, Kentucky, 40404. [2]Vanderbilt University School of Medicine, Nashville, Tennessee, 37232.

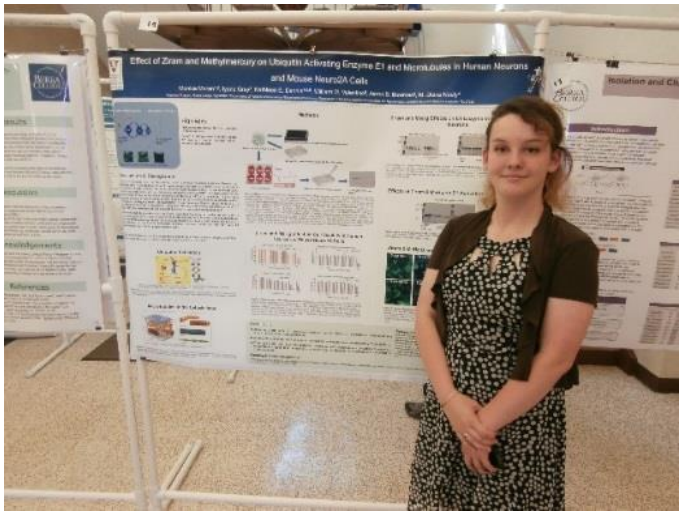
Ziram, a commonly used fungicide and potential risk factor for Parkinson's disease, and methylmercury (MeHg), a neurodevelopmental toxicant, share reactivity with sulfhydryl groups (SH). The E1 enzyme of the ubiquitin signaling cascade, a cellular pathway implicated in Parkinson's disease, and microtubules, a component of the cellular cytoskeleton crucially important for axonal growth during neural development, are both sensitive to SH-reactive compounds. Ziram has previously been shown to inhibit E1 ubiquitination although the mechanism underlying E1 inhibition is not fully established. In this study we compare the effects of Ziram and MeHg on E1 enzyme ubiquitination by western blot and on microtubule morphology by immunocytochemistry. We show here for the first time that both compounds, Ziram and MeHg, cause the loss of E1-ubiquitination in human cortical glutamatergic neurons differentiated from induced pluripotent stem cells. Interestingly, in Neuro2A cells, a mouse neuroblastoma cell line, the E1 enzyme ubiquitination was not inhibited by either toxicant suggesting that the E1 enzyme in human neurons is more sensitive to Ziram and MeHg than E1 in Neuro2A cells. Immunocytochemistry of microtubules in Neuro2A cells after exposure to Ziram and MeHg revealed disrupted microtubules. Future studies will be aimed at understanding the underlying mechanisms that from our preliminary findings appear to be distinct for the two toxicants.

KUH/NIH Summer Research Conference, August 3-4, 2016, Mayo Clinic, Rochester, Minnesota (Poster Presentation)

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Poster Presentation)

102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Poster Presentation- Cellular & Molecular Biology)

Funded by Berea College Office of Internships and Hal Moses/Aspirnaut Research Internship, Vanderbilt University



Seed Germination Ecology of the Rare Yellow Gentian (*Gentiana flavida*) in Madison County, Kentucky: A Population in Peril? Sean Nilan, Aaron Morgan and Christopher Adams. Biology Program, Berea College, Berea, Kentucky, 40404.

Gentiana flavida (yellow gentian) is a perennial member of the Gentianaceae that grows in open habitats, such as old fields, mesic soil prairies, and limestone glades. In Kentucky, *G. flavida* is known to occur in only seven counties, including Madison County where only one population has been discovered. The purposes of this study were to determine (1) if there is year to year variation in the seed germination patterns of the species, (2) if gibberellic acid is important in the dormancy-breaking process, and (3) which specific type of dormancy-breaking treatment is most effective. Seeds dispersed in October 2015 were subjected to various periods of cold stratification (0-12 weeks) at 5°C, then moved to 25°C where daily germination was monitored. Ten to twelve weeks of cold stratification produced significantly higher germination than the other treatments (28% and 34%, respectively), as was observed in the 2013 and 2014 cohorts. Germination percentages from the 2015 cohort, however, were significantly lower (<30%) than those of both the 2013 and 2014 cohorts. Furthermore, seeds collected in 2015 exhibited extremely low viability. Significant year to year variation in cohort germination has been observed. Gibberellic acid was effective in breaking physiological dormancy, resulting in relatively rapid germination. Seeds were exposed to treatments of GA3, GA4+7, and a combination of GA3,4+7 at various concentrations. GA3 produced germination (30-40%) at the higher concentrations (500, 750, and 1000 ppm), indicating that gibberellins are likely responsible for releasing the seeds from their dormant condition following the cold stratification cue in nature.

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Oral Presentation)

102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Oral Presentation- Botany: 3rd Place Undergraduate Research Competition)

Funded by Berea College URCPP

Intraepithelial Cells in an NOD IL10-/- ABo DQ8 Mouse Model of Celiac Disease. Hsuan Peng[1], Eric Marietta[2], Shahryar Khaleghi-Rostamkolaei[2] and Joseph Murray[2]. [1]Biology Program, Berea College, Berea, Kentucky, 40404. [2]Mayo Clinic, Rochester, Minnesota, 55905.

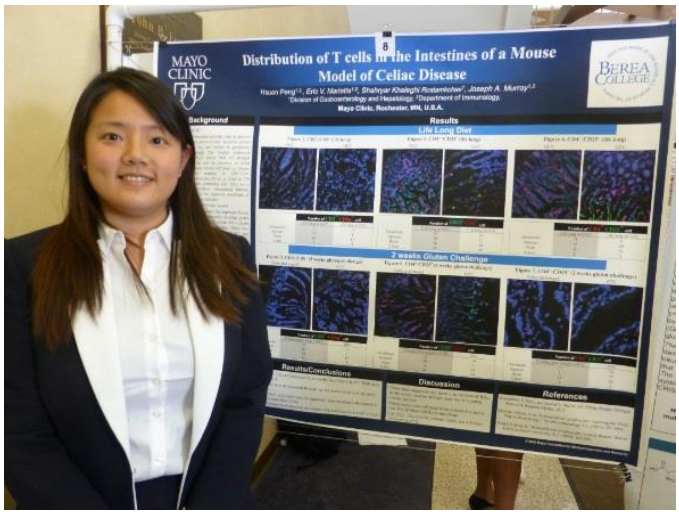
Celiac disease (CD) is characterized by villous atrophy and an increase in intraepithelial lymphocytes (IEL). The increase in IEL numbers required for diagnosis is defined as being greater than 40 IELs/100 enterocytes while on a gluten containing diet. These IELs are inflammatory/cytotoxic (CD3+/CD8+). To better understand the gluten dependent kinetics of the distribution of IELs in celiac disease, we used an NOD IL10-/- Abo DQ8 mouse model, in which gluten dependent blistering and gluten dependent diarrhea occur while on a gluten containing diet. These mice were weaned and maintained on a gluten free chow and then at 6-12 weeks of age, their gluten free chow was switched to a gluten containing chow. The distribution of CD3+, CD4+, and CD8+ cells were evaluated by immunohistochemistry and confocal laser microscopy. We found that there was an increase in the number of CD3+CD8+ cells in 2-3 weeks after a switch to a gluten containing chow. Thus, IELs appear to increase in the small intestine of our NOD IL10-/- ABo DQ8 CD mouse model quickly after a gluten challenge.

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Poster Presentation)

102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Poster Presentation—Cellular & Molecular Biology: 1st Place Undergraduate Research Competition)

Autumn Immunology Conference, November 19th, 2016, Chicago Marriott Downtown Hotel, Chicago, Illinois (Poster Presentation: 1st Place Undergraduate Research Competition)

Funded by Mayo Clinic Graduate School



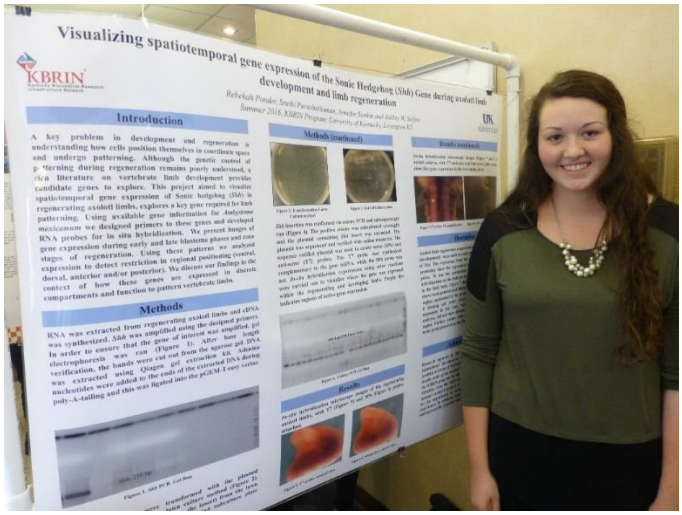
Visualizing Spatiotemporal Gene Expression of the Sonic Hedgehog (Shh) Gene during Dxolotl Limb Development and Limb Regeneration. Rebekah Ponder[1], Dr. Ashley Seifert[2], Dr. Jennifer Simkim[2] and Sruthi Purushothaman[2]. [1]Biology Program, Berea College, Berea, Kentucky, 40404. [2]University of Kentucky, Lexington, Kentucky, 40506.

A key problem in embryonic development and regeneration is understanding how cells position themselves in coordinate space to achieve patterns within the developing tissue structure. Although the genetic control of patterning during regeneration remains poorly understood, a rich literature on vertebrate limb development provides candidate genes to explore. The objective of this project was to visualize spatiotemporal gene expression of Sonic hedgehog (Shh), a gene required for patterning, regenerating and developing axolotl limbs. Using available mRNA sequence information for *Ambystoma mexicanum*, we designed primers to Shh, and developed RNA probes for in situ hybridization. We present images of gene expression during several phases of limb development and early regeneration. We used these expression patterns to determine if Shh expression was restricted along anteroposterior and dorsoventral axes. We discuss our findings in the context of how discrete compartmentalized expression of this gene might function to control patterning of axoltl limbs during regeneration.

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Poster Presentation)

102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Poster Presentation- Physiology and Biochemistry)

Funded by Kentucky Biomedical Research Infrastructure Network (KBRIN)



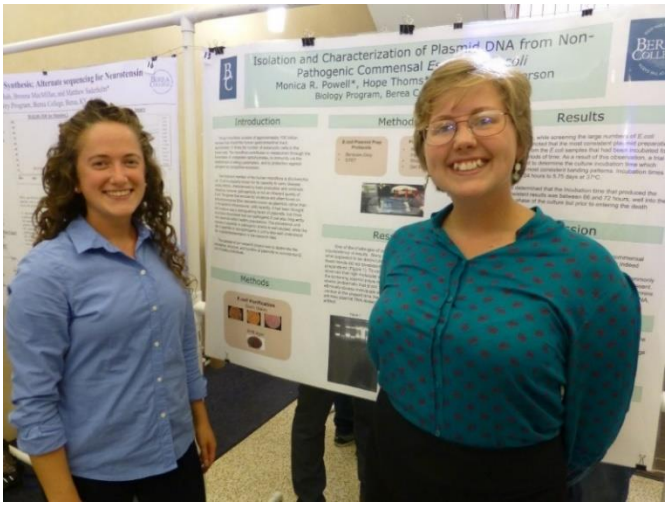
Isolation and Characterization of Plasmid DNA from Non-Pathogenic Commensal Gut *E. coli*. Monica Powell, Hope Thoms and Dawn J. Anderson. Biology Program, Berea College, Berea, Kentucky, 40404.

The human gastrointestinal tract contains approximately 300-1,000 different species of microorganisms. Escherichia coli plays a key role within this ecosystem and comprises a significant fraction of normal gut flora. Pathogenic E. coli strains, however, are far from beneficial and are responsible for many illnesses such as gastroenteritis and urinary tract infections. Many of these pathogenic E. coli possess plasmid molecules that code for virulence factors such as antibiotic resistance, toxins, invasins and adhesion factors. The plasmids contained in these pathogens have been the focus of much research. However, the plasmid populations in the non-pathogenic E. coli strains found in the human gastrointestinal tract have not been as widely studied. Previous research (2013, 2014) suggested that approximately 20% of E. coli gut flora random sample isolates seem to possess plasmid molecules based electrophoretic data. In this study, plasmid extracts from commensal E. coli gut flora samples were found to display a high degree of low and high molecular weight band similarity, which was unexpected. RNase I treatment does not lead to degradation of these molecules. Additional studies are underway to determine the identity of these molecules.

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Poster Presentation)

102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Poster Presentation- Microbiology)

Funded by Berea College URCPP



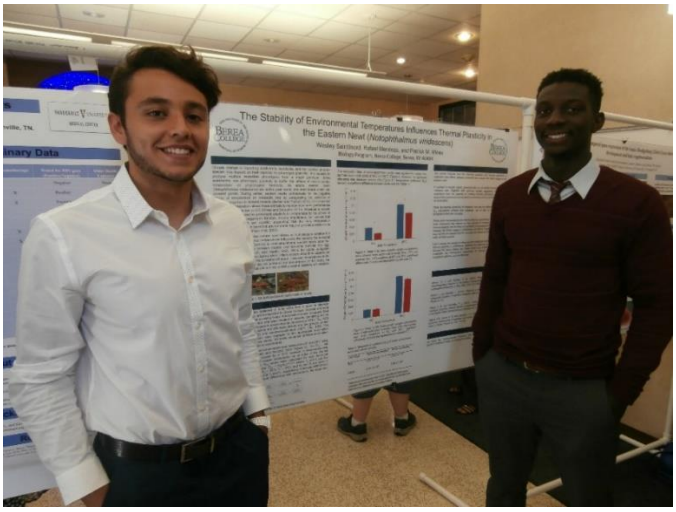
The Stability of Environmental Temperatures Influences Thermal Plasticity in the Eastern Newt (*Notophthalmus viridescens*). Wesley Saintilnord, Rafael Mendoza and Patrick Mineo. Biology Program, Berea College, Berea, Kentucky, 40404.

Body temperature affects the rates of biochemical reactions that underlie physiological rate processes (locomotor performance, immune response, feeding and growth, and metabolism). Ectotherms are especially affected by changes in thermal conditions, unless the effects of body temperature on physiological functions are buffered by compensatory responses. Some amphibians undergo thermal acclimation to reversibly change their physiology to compensate for changing temperatures. Among amphibians, the capacity to undergo thermal acclimation is restricted to aquatic species or life stages, suggesting that the capacity to undergo seasonal plasticity requires a reliable thermal cue. Our aim was to determine whether the stability of environmental temperatures influences thermal plasticity of the Eastern newt (*Notophthalmus viridescens).* Eastern newts have three life stages: aquatic larva, terrestrial juvenile eft, and aquatic adult. Both adult and juvenile Eastern newts from Madison County, KY were acclimated to winter conditions (8˚C, 10L:14D) and summer conditions (26˚C, 14L:10D) for six weeks. Upon acclimation, their metabolic rates were measured at 8˚C and 26˚C. The metabolic rates of winter-acclimated adults were higher than summer-acclimated adults at 8˚C and 26˚C. However, acclimation did not affect the metabolic rate of efts. These results demonstrate that Eastern newts compensate for the effect of low temperature by upregulating their metabolic rates, but only during their aquatic life stage.

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Poster Presentation)

102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Poster Presentation- Physiology and Biochemistry)

Funded by Berea College URCPP



The Role of TAp63 in Epidermal Wound Healing. Zachary Setters[1], Taylor Wallace[2] and Dennis Roop[2]. [1]Biology Program, Berea College, Berea, Kentucky, 40404. [2]Anschutz Medical Campus, University of Denver, Denver, Colorado, 80045.

The epidermis is the epithelial layer that serves as a barrier between us and the outside world and is mainly made up of stratified squamous cells called keratinocytes. The epidermis consists of four layers. The basal layer which contains K5 and K14 expressing cells, the spinous layer which contains cells expressing K1 and K10, and the granular and cornified layers which express a host of other epidermal differentiation factors. The factor we were interested in was the gene, TAp63. We wanted to determine if the TAp63α isoform of the gene had an effect on the speed of the wound healing process. We hypothesized that the presence of the gene would speed the process up. The data collected using a tetracycline inducible mouse model shows that our hypothesis may be correct. It shows that the bigenic mice had TAp63α expression from the onset and that they appeared to be further on in the healing process throughout the experiment. However, more tests need to be conducted before any definitive conclusions can be made.

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Oral Presentation)

102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Oral Presentation)

Funded by Berea College Office of Internships

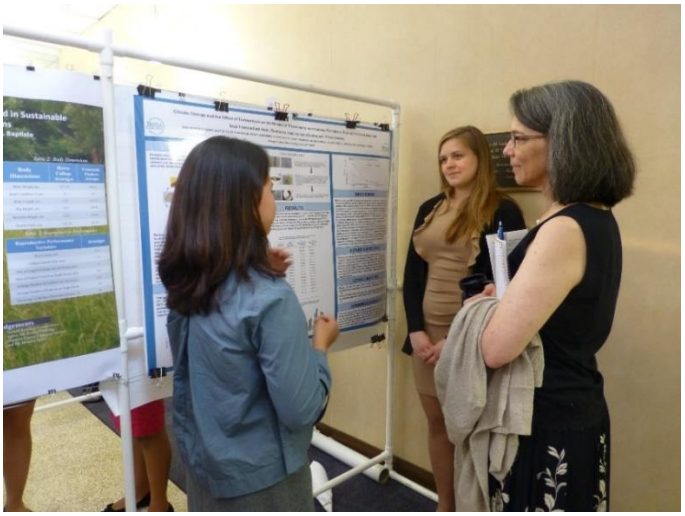
Climate Change and the Effect of Temperature on the Release of *Proterometra macrostoma* (Trematoda: Digenea) Cercariae from their Snail Intermediate Host, *Pleurocera semicarinata* (Gastropoda: Pleuroceridae). Olivia Slater, Nina Meneses, Robin Hauschner, Favour Akabogu, Aubrey Melton, Casey Tetidrick, Sarah Blank and Ron Rosen. Biology Program, Berea College, Berea, Kentucky, 40404.

Digenetic trematodes are potentially susceptible to changes in temperature during the free-living stages of their life cycles and as internal parasites within their ectothermic molluscan hosts. Even small increases in temperature associated with climate change could increase the proliferation of their infective stages. The objectives of this study were to assess the effect of temperature on the release of the *Proterometra macrostoma* cercaria from its snail intermediate host, *Pleurocera semicarinata*, determine Q_{10} temperature values, the METT (minimum emergence temperature threshold) and the MDTT (minimum development temperature threshold). There was a steady increase in cercarial emergence up to 25° C, after which cercarial release leveled off. The METT was determined to be at approximately 13° C and the MDTT between 10-12°. These values are intermediate between cercarial emergence patterns summarized for digeneans that are low latitude (≤ 35°) and mid-latitude (36-60°) species. Q_{10} values calculated at 5° and 10° C increments were greatest at the lowest temperature intervals followed by a steady decline at the higher temperature intervals. In the future it is possible that the optimal range for *P. macrostoma* cercarial release will extend into the late fall and early winter resulting in year round infections of its centrarchid fish definitive hosts.

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Poster Presentation)

102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Poster Presentation- Ecology and Environmental Science: 2nd Place Undergraduate Research Competition)

Funded by Berea College URCPP



Helping Students Succeed in Anatomy and Physiology I: A Three-Year Study of a Peer Assisted Learning Program. Casey Tetidrick, Aubrey Melton, Chioma Amaechi, Willie Gosnell, Yunpeng Xia and Sarah Blank. Biology Program, Berea College, Berea, Kentucky 40404

Anatomy and Physiology (A&P) I is a challenging gateway course for nursing and health and human performance majors. Nationally and at Berea College, this course has a high attrition (≥40%). In order to increase student success, a three-year study was designed to examine the effectiveness of a Peer-Assisted Learning (PAL) Program which was implemented in the A&P courses. A&P I students were required to co-register for a PAL course that met for 50 – 70 minutes, two times per week. Attendance, preparedness, and participation determined the PAL grade which counted as 8% of the student's course grade. Analysis of both quantitative and qualitative data indicated that the PAL program increased student success (final grade ≥C) in A&P I. Only 36% of A&P I students were successful in Fall 2012 compared to the significantly higher student success in three subsequent semesters [55% (Fall 2013), 69% (Fall 2014) and 67% (Fall 2015)] following the implementation of the PAL Program. Data suggest that the PAL program has greater benefits for African Americans and males, thus, PAL may be assisting in closing the success gaps that exist between cohort types and genders in A&P I at Berea College. Analysis of student responses on post-term surveys revealed that the majority of students agreed that PAL sessions helped in learning course content, assisted in teaching learning strategies and encouraged critical thinking. Students also agreed and that they were more successful in A&P I due to the PAL program and would recommend its use in the future.

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Oral Presentation)

102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Oral Presentation- Science Education: 2nd place Undergraduate Research Competition)

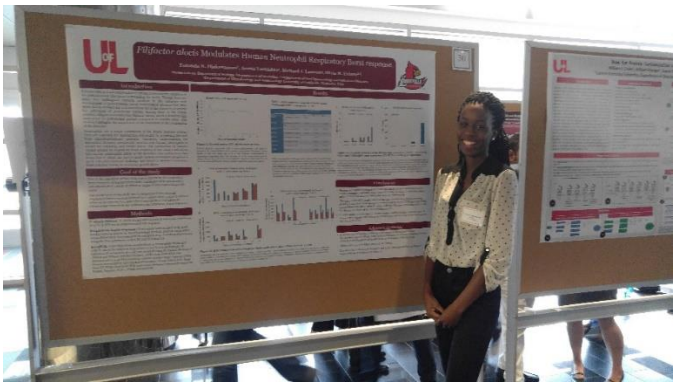
Funded by Berea College URCPP

***Filifactor alocis*, a Newly Appreciated Oral Pathogen, Modulates Neutrophil Respiratory Burst Response.** Tutonda Diakanamua[1] and Silvia M. Uriarte[2]. [1]Chemistry Program, Berea College, Berea, Kentucky 40404. [2]Department of Medicine - Nephrology Division, University of Louisville, Louisville, Kentucky, 40208.

Periodontitis is a microbial-induced chronic inflammatory condition of the tissues surrounding the tooth. The application of high-throughput sequencing technologies to the oral microbiota, has resulted in the recognition of several newly appreciated organisms which are associated with periodontal lesions. Among these is the Gram-positive anaerobic rod *Filifactor alocis*, which is present in high numbers in periodontal disease sites compared to healthy sites. Neutrophils are a major component of the innate host response and contribute to the maintenance of periodontal health by protecting the tissue against bacterial infection. The outcome of the interaction between periodontal bacteria and neutrophils is thus a key determinant of oral health status. The main objective of this project is to determine if human neutrophils challenged with opsonized or non-opsonized *F. alocis*, during the different stages of bacterial growth, will mount a different neutrophil bacterial killing response. One of neutrophils' main antimicrobial mechanisms is the ability of the cell to mount a robust respiratory burst response which results in the generation of reactive oxygen species (ROS) within the bacteria-containing phagosome. Our preliminary *in vitro* data demonstrate that *F. alocis* can survive within human neutrophils up to 24 h post challenge, and that the bacterium, during its stationary growth phase, fails to induce neutrophil respiratory burst response. We found that *F. alocis'* inability to mount an appropriate respiratory burst response relies on the capacity of the bacterium to modulate the expression of the different components required to activate the antimicrobial oxygen-dependent response.

102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Poster Presentation-Microbiology)

Funded by KY Biomedical Research Infrastructure Network (KBRIN), University of Louisville



Improving Long-Term Outcomes in Retinoblastoma Survivors. Marah Zeidan[1], Kristin Carson[2] and Debra Friedman[2]. [1]Biology Program, Berea College, Berea, Kentucky, 40404. [2]Department of Pediatrics, Division of Hematologic Oncology, Vanderbilt University Medical Center, Nashville, Tennessee, 37232.

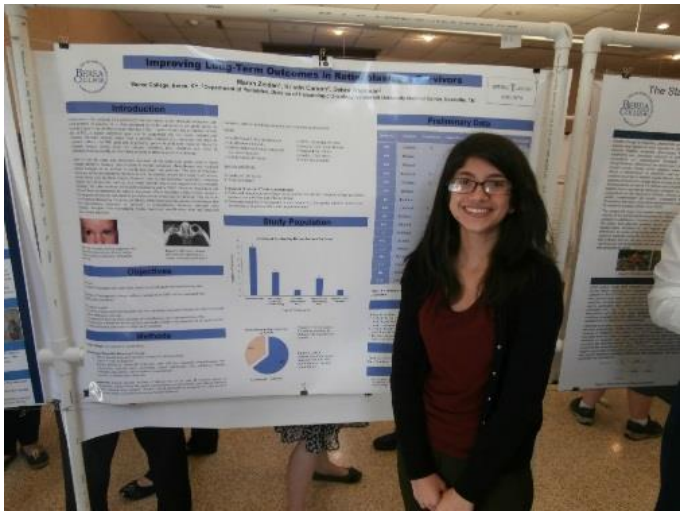
Retinoblastoma is the paradigm for a genetically inherited cancer, a rare intraocular malignancy that is found in children. Cure rates for retinoblastoma when treated with enucleation (removal of the entire eye), and/or external beam radiotherapy (EBRT) approach 100%. However, cure has been accompanied by adverse long-term effects including visual defects, cataracts, second malignant neoplasms and impaired psychosocial and neurocognitive function. This has led to the use of intravenous and intra-arterial chemotherapy approaches, but outcomes of these more contemporary therapies are less well studied. We hypothesize that contemporary therapy without enucleation or EBRT will be associated with less long-term morbidity. In our ongoing pilot cohort study, we aim to enroll 30 patients with their adult caregiver and sibling to obtain preliminary data. We hope to inform a large multi-institutional study that can define long-term outcomes for survivors treated with contemporary therapy. Enrolled patients consist of survivors of retinoblastoma diagnosed at age 0-4 and treated at Vanderbilt from 2002 to current and according to inclusion criteria. All participants complete a set of baseline questionnaires and provide a blood specimen at study entry. Furthermore, medical record abstractions are completed for each enrolled survivor to document treatment and outcomes. To date, 17 patients are enrolled and data analysis is pending. Our long-term goal of this proposed research is to understand the long-term outcomes of retinoblastoma survivors treated since the mid-1990s and determine whether we have truly been successful in improving outcomes and addressing which therapy is the optimal choice for most children.

Vanderbilt Student Summer Association Research Symposium, August 4th, 2016, Vanderbilt Medical Center, Nashville, Tennessee (Poster Presentation)

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Poster Presentation)

102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Poster Presentation- Health Sciences)

Funded by Undergraduate Clinical Research Internship Program (UCRIP), Vanderbilt University and Berea College Office of Internships



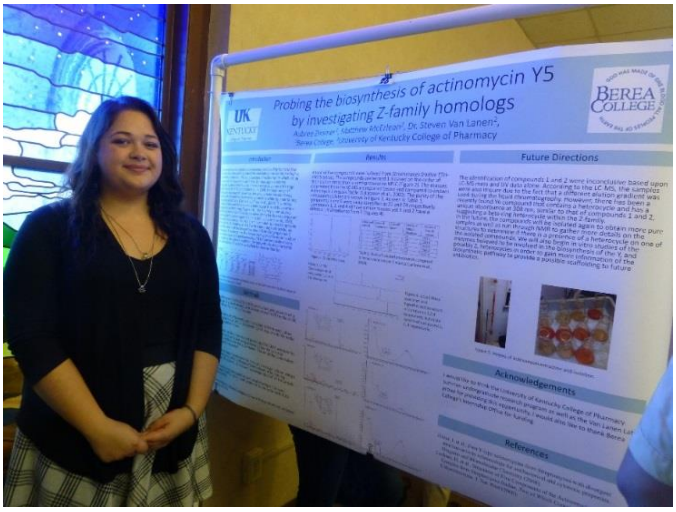
Probing the Biosynthesis of Actinomycin Y5 by Investigating Z-family Homologs. Aubree Zimmer[1], Matthew McErlean[2] and Dr. Steven Van Lanen[2]. [1]Biology Program, Berea College, Berea, Kentucky, 40404. [2]University of Kentucky, Lexington, Kentucky, 40506.

With bacteria rapidly increasing their resistance to current medications, research is looking towards new, novel compounds to combat infectious diseases. *Streptomyces* produce actinomycins which have antibacterial properties, but are also incredibly cytotoxic. However, actinomycin Y5 maintains antibacterial activity without being toxic to cells. It is believed that this unique functionality is due an extra heterocyclic ring in the structure, and it is the biosynthesis of this heterocycle that we aim to discover. To probe this mechanism, we isolated Z-family homologues using HPLC separation methods and identified the compounds using LC-MS to determine the masses that are unique to each type of actinomycin. We are looking for a potential actinomycin Z compound that may also have a heterocycle to give insight into the biosynthetic pathway of actinomycin Y5.

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Poster Presentation)

102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Poster Presentation- Physiology and Biochemistry)

Funding by UK College of Pharmacy



The Expression of PD-L1 in the Hair Follicle. Jacquie Zimmerman[1], Dr. Bradley Kubick[2] and Dr. Dennis Roop [2]. [1]Biology Program, Berea College, Berea, Kentucky, 40404. [2]Anschutz Medical Campus, University of Denver, Denver, Colorado, 80045.

Immunoediting is a dynamic process that consists of immunosurveillance and tumor progression. It is made up of three phases: elimination, equilibrium and escape. Using this as the basis of the project, the mechanisms that initiate/allow for tumor cells to bypass elimination and enter into the equilibrium and escape phases through the use of a mouse model of inducible/traceable carcinogenesis were studied. The significance of my contribution to this project was detecting the expression of PD-L1, the programmed death ligand 1, whose interaction is believed to play a large role in allowing transformed tumor cells to bypass the cell's elimination.

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Oral Presentation)

102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Oral Presentation-Cellular and Molecular Biology)

Funded by Berea College Office of Internships

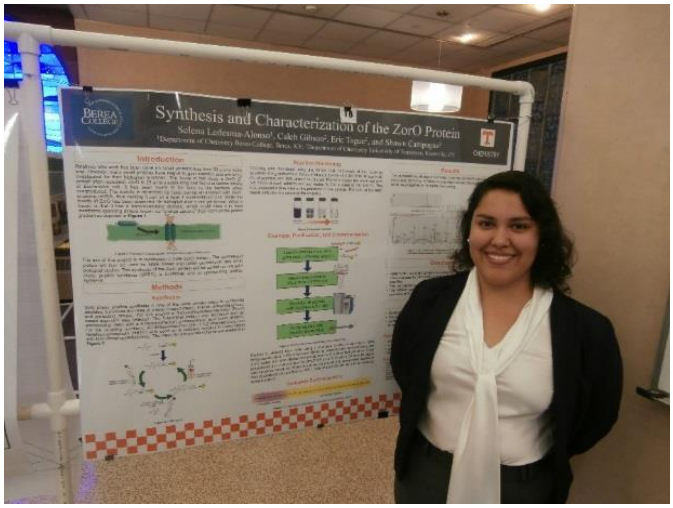
Synthesis and Characterization of the ZorO Protein. Selena Ledesma-Alonso[1], Caleb Gibson[2], Eric Tague[2] and Shawn Campagna[2]. [1]Chemistry Program, Berea College, Berea, Kentucky, 40404. [2]University of Tennessee, Knoxville, Tennessee, 37996.

Relatively little study has focused on small proteins less than 50 amino acids long, which are translated from small open reading frames. However, many small proteins have begun to gain attention and are being investigated for their biological functions. Z protein often repeated (ZorO), one of these small proteins, is 29 amino acids long and found in pathogenic *Escherichia coli*. This protein is toxic to the bacteria when overproduced, and this toxicity is repressed by the base pairing of an antitoxin with the ZorO-encoding mRNA, thus making a type 1 toxin-antitoxin pair. While the toxicity of ZorO has been observed, its full biological role is not yet known. However, there it is hypothesized that the proteins ability to dimerize is related to its biological function. The aim of this project is to synthesize pure ZorO protein. The synthesis of the protein was carried out via solid phase peptide synthesis (SPPS), which involves the use of a solid support (resin), linkers, activating groups, and protecting groups. For this project an fluorenylmethyloxy-carbonyl (Fmoc) based approach was selected. The C-terminal residue was anchored onto an aminomethyl resin with a 4-(hydroxymethyl)phenoxyacetic acid (HMPA) linker. For the coupling reactions, 2-(1H-benzotriazol-1-yl)-1,1,3,3-tetramethyluronium hexafluorophosphate (HBTU) was used as a coupling reagent in combination with *N*,*N*-diisopropylethylamine (DIPEA). As a result, the protein was successfully synthesized as confirmed by ultra-performance liquid chromatography—tandem mass spectrometry (UPLC-MS/MS) using a Q Exactive mass spectrometer. The synthesized protein will be used for biological studies.

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Poster Presentation)

102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Poster Presentation- Chemistry: Organic/Inorganic)

Funded by REU Program / National Science Foundation, University of Tennessee



Field Study of Glyphosate Degradation in Berea College Forest Soils. Carlos Andres Berejnoi Bejarano, Chann Makara Han, Tomas Flores, Christopher James, Priscila E. Garcia, Savannah B. Osborne and Paul C. Smithson. Chemistry Program, Berea College, Berea, Kentucky, 40404.

The Berea College Forestry Program uses glyphosate herbicide (N-(phosphonomethyl) glycine) to combat invasive exotic woody plants. Residual glyphosate may pose a health or environmental risk, so we studied the degradation rate of glyphosate in College Forest soils. From 2012 to 2014, about 300 kg glyphosate was applied to a 25-ha area infested with the invasive plants, mostly on fresh-cut stumps at about 900 mg glyphosate/kg soil on the stump area. We conducted a field study with two soil series (Blago and Captina) in the cross-country trail portion of the College Forest near Berea College. Glyphosate at 1000 mg/kg soil was applied as Rodeo^{TM} herbicide to two 1-meter quadrats at each site. Soil samples were collected from the top two soil horizons before glyphosate addition, immediately after application (day 0), and at 1, 2, 7 and 14 days after application, and were frozen at –78 ^{o}C for later analysis. We extracted the soils at 5:1 solution:soil ratio with 40 mM sodium tetraborate, and extracts were analyzed for glyphosate using electrospray ionization mass spectrometry in negative ion mode. Glyphosate recovery averaged 56% (Blago) and 91% (Captina). Soil glyphosate levels had declined to 100 ± 40 (SD) mg/kg (Blago) and 200 ± 50 mg/kg (Captina) by Day 14. We conclude that glyphosate degradation is relatively rapid in our forest soils.

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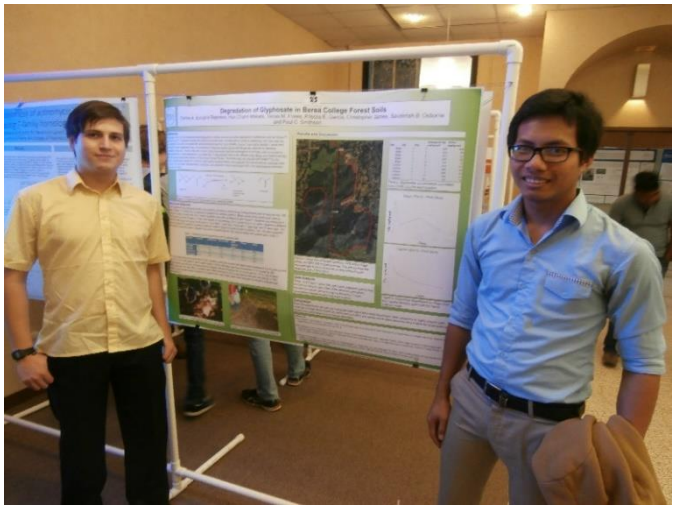
102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Poster Presentation- Ecology and Environmental Science)

Funded by Berea College URCPP



Synthesis of Fluorogenic Peptide Substrates for the Peptidase Neurolysin. Million Beshah, Michael James, Brenna Macmillan, Kateryna Nabukhotna and Matthew Saderholm. Chemistry Program, Berea College, Berea, Kentucky, 40404.

The peptidase neurolysin is an important regulatory protein. It is implicated in deactivating a range of neuropeptides that control such diverse things as blood pressure and mood. One of neurolysin's main targets is the 13---residue neuropeptide neurotensin, cleaving it between residues Pro10 and Tyr11. To probe its specifity, we synthesized internally---quenched fluorogenic peptide analogs of neurotensin, neurolysin's preferred substrate. We synthesized variants of neurotensin with a combination of solution—phase organic and solid---phase peptide chemistry, changing residues at positions 10, 11, and 12. Several of these fluorogenic peptides were cleaved with neurolysin and the kinetic parameters were determined by quantifying the products using fluorescence.

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102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Poster Presentation- Organic/Inorganic Chemistry)

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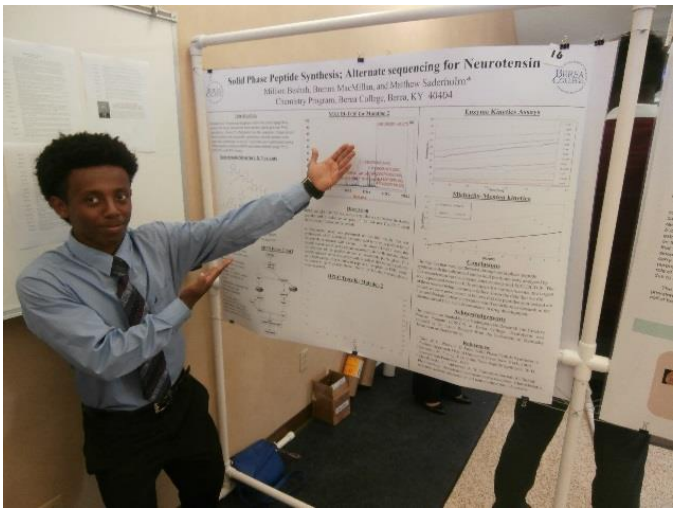

The Bioluminescent Detection of HIV Persistency. Boubacar Cherif[1], Angeliki Moutsiopoulou [2], Emre Dikici [2] and Sapna Deo[2]. [1]Chemistry Program, Berea College, Berea, Kentucky, 40404.
[2]University of Miami, Coral Gables, Florida, 33146.

More than 1.2 million people in the United States are living with Human Immunodeficiency Virus (HIV) infection, and almost 1 in 8 (12.8%) are unaware of their infection. HIV is a retrovirus that mainly targets the immune system. HIV is a very persistent virus and hides mainly in the CD4+ T-cells so it becomes impossible to completely to be eliminated from the body. The virus results in diseases such as: acquired immune deficiency syndrome (AIDS), chronic hepatitis, chronic measles encephalitis, and chronic papovavirus encephalitis. In the present work, an assay is currently being developed using a tyrosine-modified bioluminescent protein Gaussia luciferase (GLucY). GlucY was attached to a DNA stem-loop probe (SLP) along with coelenteramine as an inhibitor which is similar to the protein's native substrate. The molecular beacon's loop consists of 15-30 nucleotides which are complementary to the target (HIV mRNA). The stem contains 5-7 base pairs in which the protein and inhibitor are attached to each end. The advantage of using a SLP is that upon binding of the target to the loop region, the stem is forced apart resulting in the separation of GLucY from its inhibitor allowing the bioluminescent activity to be easily measured. We have successfully developed the SLP to facilitate the assay. A tyrosine residue was introduced, through site- directed mutagenesis, to GLucY for further conjugation with a diazonium salt, 4- Formylbenzene diazonium hexafluorophosphate (FBDP). Thus, allowing the crosslinker sulfo-S-Hynic to easily modify the protein due to the carbonyl functionality of the FBDP's moiety at the N-terminal of the stem-loop probe. The inhibitor was synthesized via a two-step organic reaction and was attached at the C- terminal with aid of 1-ethyl-3-(3-dimethylaminopropyl) carbodiimide/N-hydroxysuccinimide (EDC/NHS) chemistry. This novel methodology will allow us to acquire faster, easier, and efficient detection of HIV within a host cell.

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Poster Presentation)

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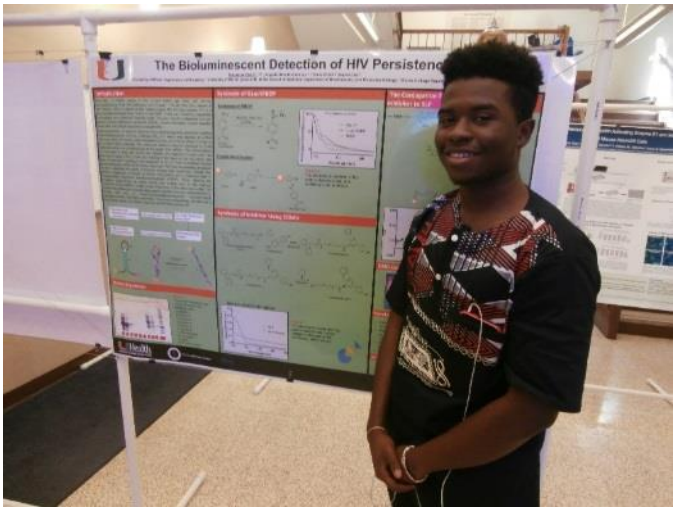
Funded by The Leadership Alliance and Berea College Office of Internships



Teratogen Toxicity in Organotypic Culture Models. Aaron Effoe[1], Peter Alexander[2] and Rocky Tuan[2]. [1]Berea College, Berea, Kentucky, 40404. [2]University of Pittsburgh, Pennsylvania, 15260

Limb developmental abnormalities represent one of the most visible birth defects. Prenatal exposure to drugs, environmental toxicants and teratogens represent a large majority of contributing factors along with other genetic factors. Our goal is to develop in vitro three-dimensional (3D) organotypic culture models (OCMs) based on human mesenchymal stem cells (MSCs) to examine crucial phenomena of embryonic limb development and susceptibility to known teratogens and environmental toxins.

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Laboratory Study of Glyphosate Degradation in Berea College Forest Soils. Tomas Flores, Christopher James, Carlos Andres Berejnoi Bejarano, Priscila E. Garcia, Chann Makara Han, Savannah B. Osborne and Paul C. Smithson. Chemistry Program, Berea College, Berea, Kentucky, 40404.

The Berea College Forestry Program uses glyphosate herbicide (N-(phosphonomethyl) glycine) to combat invasive exotic woody plants. Residual glyphosate may pose a health or environmental risk, so we studied the degradation rate of glyphosate in College Forest soils. From 2012 to 2014, about 300 kg glyphosate was applied to a 25-ha area infested with the invasive plants, mostly on fresh-cut stumps at about 900 mg glyphosate/kg soil on the stump area. We conducted a laboratory incubation study with two soil series (Blago and Captina) in the treatment area, collected from the top two soil horizons. Glyphosate was added at 1000 mg/kg soil in sufficient water to achieve about 25% moisture content, and soils were incubated at 25 °C on a 12:12 light:dark cycle. Soils were extracted before glyphosate addition, immediately after application (day 0), and at 1, 2, 7 and 14 days after application. Soils were extracted at 5:1 solution:soil ratio with 40 mM sodium tetraborate, and extracts were analyzed for glyphosate using electrospray ionization mass spectrometry in negative ion mode. Glyphosate recovery averaged 56% (Blago) and 91% (Captina). Soil glyphosate levels had declined to 100 ± 40 (SD) mg/kg (Blago) and 200 ± 50 mg/kg (Captina) by Day 14. We conclude that glyphosate degradation is relatively rapid in our forest soils.

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102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Poster Presentation- Ecology and Environmental Science)

Funded by Berea College URCPP

Land Use History, Soil Characterization and Invasive Species in the Berea College Forest. Priscila E. Garcia, Savannah B. Osborne, Carlos Andres Berejnoi Bejarano, Tomas M. Flores, Chann Makara Han, Christopher James and Paul C. Smithson. Chemistry Program, Berea College, Berea, Kentucky, 40404.

Berea College manages about 9000 acres of forest land that is a valuable part of student life and learning at the college, and is listed on the National Register of Historic Places. The first College Forester was Silas C. Mason (1897-1908), who began land acquisition with his own funds. Most of the newly purchased land was abandoned logged-over land, pasture or cropland. Closely associated today with historical land clearance is the dominance in the understory of invasive exotic woody species, including Japanese honeysuckle (*Lonicera japonica*) and bush honeysuckle (*Lonicera maackii*) among others. To combat the spread of the invasives, the Forestry Unit uses glyphosate herbicide (Rodeo™ brand). We sampled 5 sites comprising 4 soil series in two areas of the College Forest where invasive species are a problem, and characterized the soils chemically and physically. Surface soils at most sites were very strongly acid (pH in water 3.8 to 4.4) with surface texture of clay loam to silt loam, and organic matter 3 to 44%. Two sites at the northern and southern ends of the 60-acre treatment area on the cross-country trail section of the forest (Blago and Captina soil series) were chosen for further study (see related abstracts by Bejarano et al. and Flores et al.).

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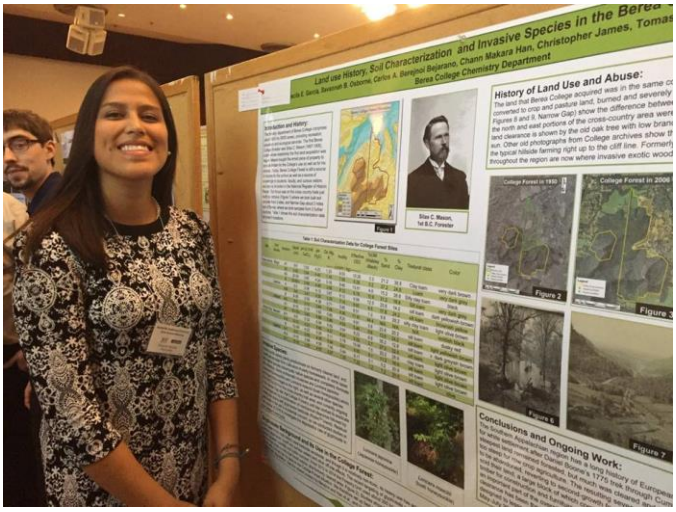

Engineering Novel Substrates for the Neuropeptidase Neurolysin. Michael B. James, Kateryna O. Nabukhotna and Matthew J. Saderholm. Department of Chemistry, Berea College, Berea, Kentucky, 40404.

Neuropeptides are signaling molecules that are heavily regulated and controlled by enzymes in the body. The neuropeptide neurotensin is implicated in dopamine modulation and blood pressure regulation. It is known that its main controlling enzyme, neurolysin, targets this 13-residue peptide, and cleaves it between the 10th and 11th positions. Since neurolysin has had limited study on its enzyme kinetics, the goal of this research was to study the effects of mutated substrates on neurolysin's activity. Several internally-quenched fluorogenic mutants of neurotensin were synthesized as substrates for neurolysin. Substitution of the residue specifically at the 11th position, from isoleucine to lysine and alanine, allowed us to test the effects of their representative polarity and size differences. The enzyme cleavage was analyzed using fluorescence resonance energy transfer (FRET) assays, and it was found that substituting lysine at the 10th position significantly reduced substrate cleavage compared to other neurotensin mutants.

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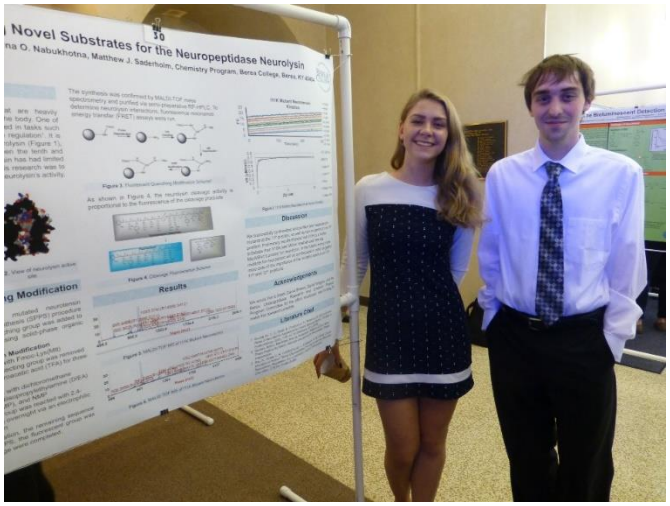
102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Poster Presentation- Chemistry: Organic/Inorganic: 2nd Place Undergraduate Research Competition)

Funded by Berea College URCPP

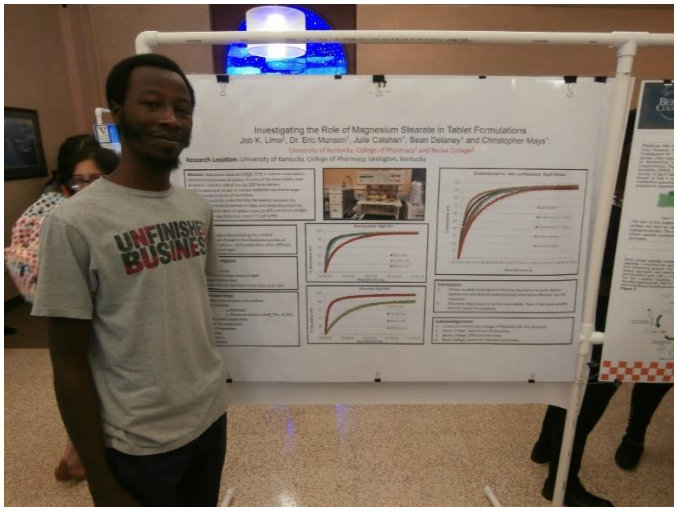


Investigating the Role of Magnesium Stearate in Tablet Formulations. Job K. Limo[1] and Eric Munson[2]. [1]Berea College, Berea, Kentucky, 40404. [2]University of Kentucky, College of Pharmacy, Lexington, Kentucky, 40506.

Magnesium Stearate (MgSt, C18) is used as a lubricant in manufacturing process of tablets. It is one of the most widely used excipients - found in 108 of the top 200 formulations. Batch to batch and vendor to vendor variability can lead to large inconsistencies in terms of tablet lubrication.This work focused on understanding the relation between the molecular properties of MgSt and tablet dissolution by running dissolution tests on tablets made using different forms of MgSt. The dissolutions were done over time in 7.2 pH buffer

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Poster Presentation)

102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Poster Presentation- Chemistry: Analytical/Physical: 1st Place Undergraduate Research Competition)



Design and Synthesis of Novel Neurotensin Analogs. Brenna MacMillan, Million Beshah and Matthew Saderholm. Chemistry Program, Berea College, Berea, Kentucky, 40404.

This undergraduate research team focused on solid phase peptide synthesis (SPPS). This method of synthesis is a relatively fast and efficient technique, in which each individual amino acid is coupled on to the carboxylic terminal of the next amino acids, forming the specific sequence necessary to create the chosen peptide. Specifically, this group synthesized variations of the fluorogenic peptide Neurotensin, which primarily contributes to dopamine regulation in the human body, but also plays a role in the nervous system. There are thirteen amino acids in the peptide Neurotensin, and by altering the tenth or eleventh amino acid in the sequence, one can observe the various functional and reactional changes that might occur. The amino acid sequence for Neurotensin is Glu-Leu-Tyr-Glu-Asn-Lys-Pro-Arg-Arg-Pro-Tyr-Ile-Leu-OH. The research team chose to replace either positions ten or eleven with larger, more polar amino acids or smaller amino acids with higher hydrophobicity. The team chose these specific locations on the peptide for the altercations because this is where Neurolysin naturally bisects the peptide between the amino acids Proline and Tyrosine, during regulation of the amount of Neurotensin in the body. These peptides were purified and analyzed by several different instruments including the HPLC, MALDI-TOF, Mass spectrometer, and fluorometer assays.

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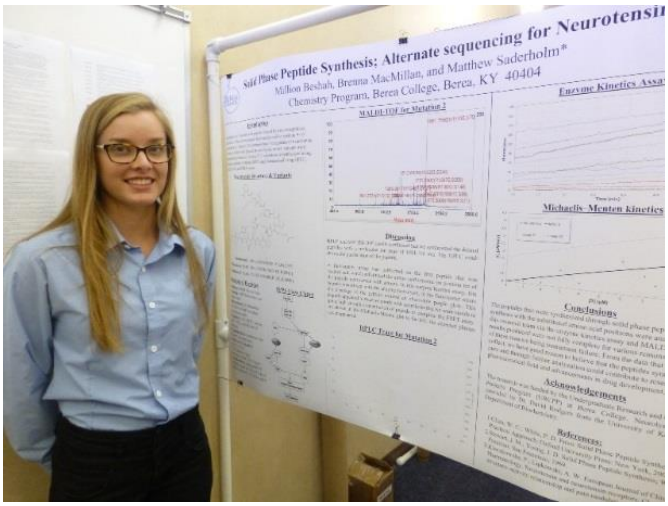
102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Poster Presentation)

Funded by Berea College URCPP



Developing Selective Inhibitors of USP7 Deubiquitinating Enzyme. Tatiana Mikhailova[1], Ilaria Lamberto[2], Xiaoxi Liu[2] and Sara Buhrlage[2]. [1]Chemistry Program, Berea College, Berea, Kentucky, 40404. [2]Dana-Farber Cancer Institute, Harvard Medical School, Boston, Massachusetts, 02115.

Ubiquitin specific protease 7 (USP7) is a deubiquitinating enzyme that cleaves ubiquitin from its substrates and rescues them from proteasome mediated degradation. Recent studies suggest an important role of USP7 in tumorigenesis. USP7 stabilizes both tumor suppressor p53 and its specific E3 ubiquitin ligase MDM2. This important role of USP7 in p53 pathway makes it a promising target for cancer therapy. Quinazolin-4-one scaffold analogues were reported as selective inhibitors of USP7. Our preliminary data shows that these inhibitors block estrogen induced cell proliferation in ER+ breast cancer cell line. We generated USP7 catalytic domain mutants and based on the ubiquitin-AMC assay data identified residues that are responsible for this selective inhibition. Results of the study are important for the development of more potent selective inhibitors of USP7 and investigating their biochemical activity in cell.

Summer Undergraduate Research Conference, August, 11, 2016, Harvard Medical School, Boston, Massachusetts (Oral Presentation)

102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Oral Presentation- Physiology and Biochemistry Section: 2nd Place Undergraduate Research Competition)

Funded by Berea College Office of Internships and Dana-Farber Cancer Institute

Encapsulation of Nanoparticles during Polymer Micelle Formation: A Dissipative Particle Dynamics Study. Kyaw Hpone Myint[1] and Lisa M.Hall[2]. [1]Chemistry Program, Berea College, Berea, Kentucky, 40404. [2]Ohio State University, Columbus, Ohio, 43210.

Polymer-protected medical nanoparticles are of interest for drug delivery, medical imaging and cancer therapy. Despite their widespread usages, the formation of nanoparticle-containing micelles is not fully understood at the molecular level. Developing a model provides a way to visualize and observe the molecular implications of various polymer interactions during micelle formation, which are not possible to observe in physical experiments. The goals of this study are: (1) to model the encapsulation of nanoparticles to get understanding of micelle formation at the molecular level, and also (2) to explore the experimentally controllable parameters affecting the uniformity of micelles, which would ultimately give us a way to control the micelle size commercially. We successfully developed a DPD model for the encapsulation of nanoparticles, and our findings show that changing each parameter has the predictable effect on the micelle formation process.

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Oral Presentation)

102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Oral Presentation-Chemistry: Analytical/Physical—1st Place Undergraduate Research Competition)

Funded by Berea College Office of Internships

Functional Role of the Cytoplasmic Tail of α Subunit of α3β1 Integrin in Migration and Adhesion to LM-511. Christinia Patel[1], Olga Viquez[2] and Roy Zent[2]. [1]Chemistry Program, Berea College, Berea, Kentucky, 40404. [2]Vanderbilt University School of Medicine, Nashville, Tennessee, 37232.

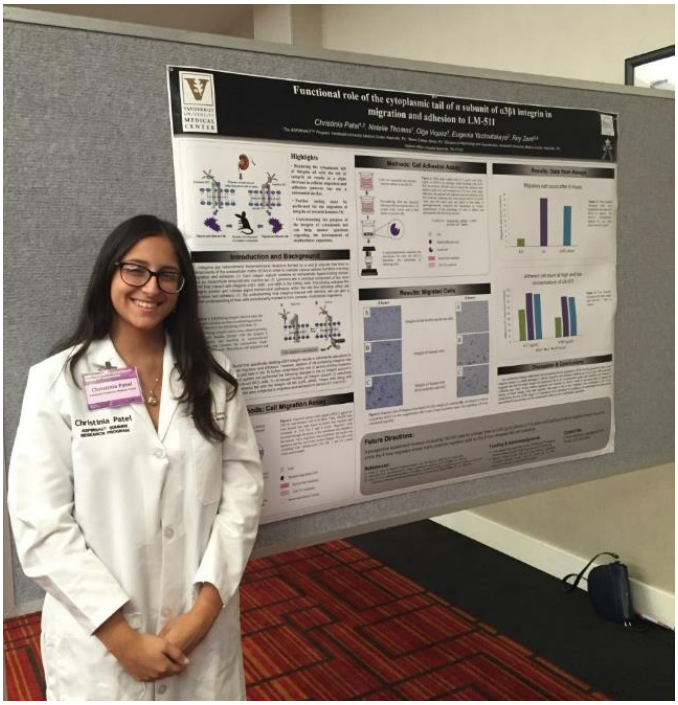
The goal of this experiment was to establish the role of the integrin α3 cytoplasmic tail of integrin α3β1 in cell migration and adhesion within collecting ducts cells. Cell migration and adhesion assays involving the integrin-containing cells' attraction to laminin-511 were performed and migratory and adherent cells were counted to quantify their migration and adhesion patterns. Cells containing the following forms of the protein were studied: unaltered integrin α3β1, chimeric integrin in which the α3 cytoplasmic tail was substituted for the α6 cytoplasmic tail, and integrin α3α6 double knock-out cells. We discovered that switching the tails resulted in no major differences in migration or adhesion patterns which suggest that the α3 tail has no substantial role in mediating cell migration and adhesion. By understanding the importance of the integrin α3 cytoplasmic tail, we can gain deeper insights into how cells arrange and adhere to one another and the extracellular matrix to develop complex, multicellular organisms.

KUKUH Summer Undergraduate Research Conference, August 6th- 8th, 2016, Mayo Clinic, Rochester, Minnesota (Poster Presentation)

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Poster Presentation)

102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Poster Presentation-Physiology and Biochemistry)

Funded by Berea College Office of Internships and Hal Moses/Aspirnaut Research Internship, Vanderbilt University



Characterization of a Novel Delivery System of Cyclic Dinucleotides for Efficient Innate Immune Activation. Seth Reasoner[1], Daniel Shae[2], John Wilson[2] and Manuel Ascano[2]. [1]Chemistry Program, Berea College, Berea, Kentucky, 40404. [2]Vanderbilt University School of Medicine, Nashville, Tennessee, 37232.

Cancer immunotherapy relies on harnessing existing immune mechanisms to fight cancer and has garnered significant interest in the development of new cancer treatments. Previous research has suggested that the endogenous cyclic dinucleotide second messenger cyclic guanosine-adenosine monophosphate (cGAMP) may have unique antitumor properties through its stimulation of a cellular innate immune response. cGAMP directly activates the protein STING (Stimulator of interferon genes), which causes the transcriptional upregulation of type I interferons and related interferon-stimulated genes – ultimately leading to increased immunosurveillance and enhanced antitumor activity. Continued research will further elucidate the involvement of innate immune mechanisms, including STING signaling, in combatting cancer. Previous work demonstrated that the synthetic small molecule DMXAA was a potent activator of STING and antitumor agent. However, it was later discovered that DMXAA was a mouse-specific STING agonist. The most straightforward approach towards species-independent activation of STING would be to use its natural ligand, cGAMP. However, efficient delivery of exogenous cGAMP to the cytoplasm presents a challenge given that cGAMP is normally synthesized within cells and does not readily cross the plasma membrane. This project evaluated the ability of a nanoparticle vehicle to successfully deliver cGAMP to the cytoplasm in a variety of cell types, including immune cells and a breast cancer cell line. Results indicate that nanoparticle encapsulation of cGAMP dramatically improves its ability to activate innate immune pathways. This delivery system will contribute to the development of cancer immunotherapeutics and the understanding of the role STING signaling plays in anticancer mechanisms.

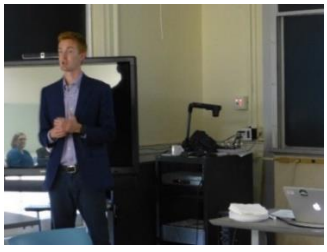
KUH/NIH Summer Research Conference, August 3-4, 2016, Mayo Clinic, Rochester, Minnesota (Poster Presentation)

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Oral Presentation)

102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Oral Presentation- Cellular & Molecular Biology: 1st Place Undergraduate Research Competition)

American Society of Nephrology National Meeting, November 17th-19th, 2016, McCormick Palace Chicago, Illinois (Poster Presentation)

Funded by Berea College Office of Internships and Hal Moses/Aspirnaut Research Internship, Vanderbilt University



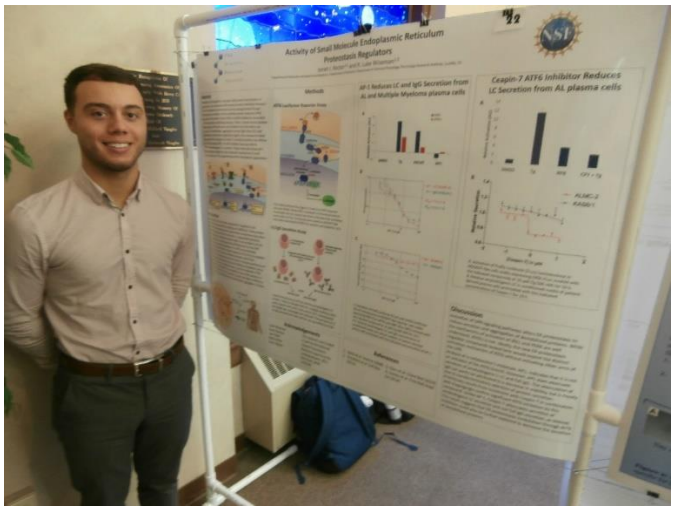
Activity of Small Molecule Endoplasmic Reticulum Proteostasis Regulators. Jonah Rector[1], Ryan Paxman[2] and Lars Plate[2]. [1]Chemistry Program, Berea College, Berea, Kentucky, 40404. [2]The Scripps Research Institute, La Jolla, California, 92037.

Disparities in endoplasmic reticulum (ER) protein homeostasis, or proteostasis, are associated with several protein misfolding diseases.1 The ER proteostasis environment can be reprogrammed through transcriptional activation of the unfolded protein response (UPR)-associated transcription factor ATF6 to rectify imbalances associated with these protein-misfolding diseases.2 Here, I tested several putative small molecule ATF6 activators and inhibitors for their effects on secretion of a destabilized, aggregation-prone light chain (LC) and energetically normal immunoglobulins (IgGs). One compound tested demonstrated the reduction of both LC and IgG secretion, but without specifically activating ATF6. An ATF6 inhibitor was also able to attenuate amyloidogenic LC secretion. These molecules along with others could give insight into the molecular mechanism of small molecule-dependent ER programming and its therapeutic applications.

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Poster Presentation)

102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Poster Presentation- Cellular and Molecular Biology)

Funded by NSF Research Experience for Undergraduates (REU), Scripps Research Institute



Impact of SRCR Domains in the Functionality and Localization of Lysyl Oxidase-Like 2 in Diabetic Nephropathy. Marco Santos[1], Abner Pena[2], Catalina Kretschmar[2], Alberto Lopez[2] and Roberto Vanacore[2]. [1]Chemistry Program, Berea College, Berea, Kentucky, 40404. [2]Vanderbilt University Medical Center, Nashville, Tennessee, 37232

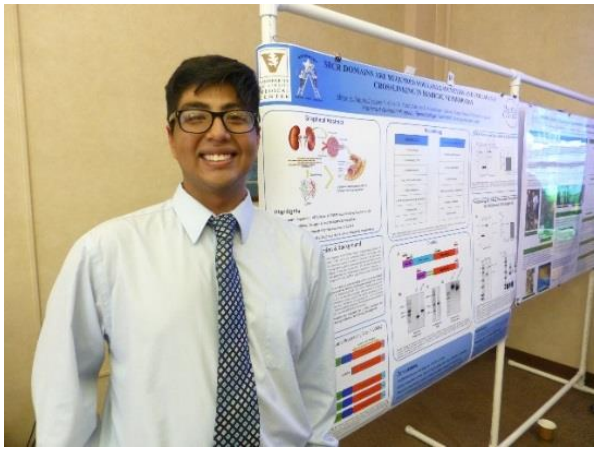
In the U.S. diabetes is considered a public health epidemic. Approximately 30-40% of diabetic patients develop diabetic nephropathy (DN), the leading cause of End Stage Renal Disease (ESRD). DN is characterized by the excessive production and accumulation of proteins in the glomerular extracellular matrix (GECM). The protein accumulation leads to mesangial expansion and thickening of the glomerular basement membrane (GBM). DN up regulates the expression of collagen IV, the main component of GBM. This anomaly increases the deposition of large supramolecular networks that are formed by the assembly and crosslinking of triple-helical molecules. Lysyl Oxidase like-2 (LOX2) is an extracellular enzyme that is also up regulated in DN. LOXL2 is the main contributor to the crosslinking of collagen IV in the GBM. In this study, our aim is to understand the role of the Scavenger Receptors Cysteine Rich (SRCR) non-catalytic domains and how they affect the functionality and localization of LOXL2. Through overlapping PCR and site-directed mutagenesis, we created different constructs by either preventing extracellular processing or truncating specific SRCR domains in order to characterize its function. Immunoblotting and lysyl oxidase activity assay of HEK 293 cells extracts expressing these constructs suggested that structural features in the SRCR region drives LOXL2 secretion to the extracellular media. From the results, it is concluded that the SRCR domains are indeed necessary for secretion, but are not required for lysyl oxidase activity in vitro. Gain of function experiments are being conducted to define the unique elements required to LOXL2 secretion.

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Poster Presentation)

102th Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Poster Presentation- Physiology & Biochemistry: 1st Place Undergraduate Research Competition)

American Society of Nephrology National Meeting, November 17th-19th, 2016, McCormick Palace Chicago, Illinois (Poster Presentation)

Funded by Berea College Office of Internships and Hal Moses/Aspirnaut Research Internship, Vanderbilt University



Diversity and Community Policing. Rashad Hayden, Bethany Turner and Kennaria Brown. Communications Program, Berea College, Berea, Kentucky, 40404.

The purpose of our project was to achieve four main goals: 1) Mentoring Berea students in cultivating informed, constructive relationships with their local police department; 2) Creating and delivering a tailored diversity training program; 3) Creating, mailing, and analyzing a community survey; and 4) Generating opportunities for collaboration between the Berea PD, Berea College, and the Berea Community. Goals 1-3 were achieved, and the community survey is the springboard for #4. Basically we learned that policing is a difficult, dangerous, job, even in Berea, and on the whole Berea's citizens recognize this fact and appreciate officers' service, while also having constructive ideas for improving their service and relationships with Berea's citizens. The officers were receptive to the diversity training as we paired what we learned in the academic world with what we learned from their world, creating and conducting a challenging but uplifting diversity training program. We are still analyzing the data from the survey and will generate a report for Chief Gregory by August 31st.

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Poster Presentation)

Funded by Berea College URCPP

Counting Trees. Albert Artiles, Beth Kelly and James Blackburn-Lynch. Mathematics Program, Berea College, Berea, Kentucky, 40404.

Mathematical phylogenetics involves the study of the underlying properties of phylogenetic trees, that is, trees (in a graph theory sense) with labeled leaves. In our research, we study three questions: (1) How to construct trees with given relationship information between species, (2) how many trees are possible (of a particular type) given a set of species, and (3) how many species must a pair of trees agree on.

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Oral Presentation)

Funded by Berea College URCPP

Phylogenetics and Hierarchies. Malachi Holden, Beth Kelly and James Blackburn-Lynch. Mathematics Program, Berea College, Berea, Kentucky, 40404.

Phylogenetic systematics is the field of biology that studies the patterns of relationships between organisms and seeks to reconstruct evolutionary history. Mathematical biologists make use of combinatorics, algebra, and set theory to better map these relationships. My research was concerned with studying the properties of the mathematical trees that phylogeneticists use to map evolutionary history. I worked with a mathematical structure called a hierarchy, which is related to trees in the way it organizes information.

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Poster Presentation)

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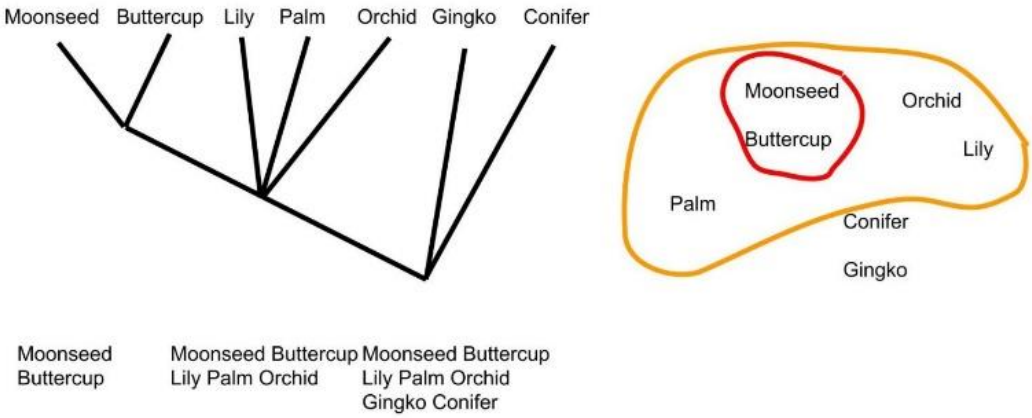

Comparing Two Unrooted Phylogenetic X-trees. Bhavesh Ramkorun, Beth Kelly and James Blackburn-Lynch. Mathematics Program, Berea College, Berea, Kentucky, 40404.

A phylogenetic X-tree is a tree T with a labelled leaf set X. An application is to study the evolutionary relationship between a set of species. We look at how to compare two different unrooted phylogenetic X-trees, T and T', which have the same labelled leaf set, X, to see how they agree with each other. We try to understand how any two phylogenetic X-trees will agree with each other when the size of X increases.

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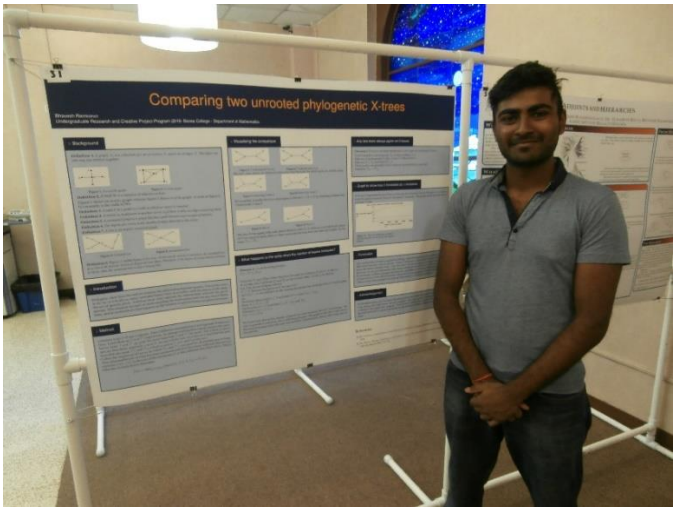
102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Poster Presentation-Mathematics: 1st Place Undergraduate Research Competition)

Funded by Berea College URCPP



Thermo-Magnetic Properties of High-Entropy Alloys (HEAs). Robert Barnes, Nathaniel Bodine, Tanner Thompson and Troy Messina. Physics Program, Berea College, Berea, Kentucky, 40404.

Our group researched the thermo-magnetic properties of certain high-entropy alloys (henceforth HEAs). These alloys contain iron, nickel, cobalt, a varied amount of chromium, and a variable element of different concentrations of gold or silver. We arc melted samples and tested them with x-ray diffraction to determine that they alloyed properly. A magnetometer was used to measure the thermo-magnetic properties of our HEAs. We annealed samples to different temperatures to measure how this affected our samples. This work was prompted by a paper which detailed theoretical Curie temperatures and magnetic moments for these alloys.

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Poster Presentation)

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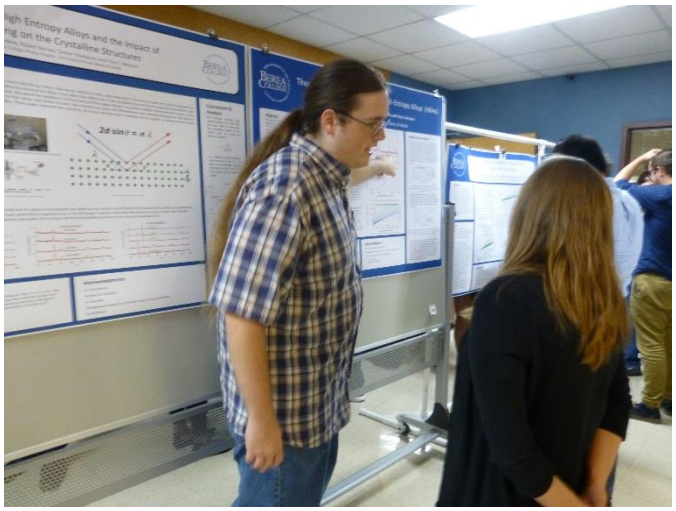

Development of Open Source Computer Simulation for STEM Fields. Denzell Barnett, Guillermo Ramos-Macias and Martin Veillette. Physics Program, Berea College, Berea, Kentucky, 40404.

For this project we have developed an open source computer simulation based on Plinko game. The simulation targets middle and high school students and teaches concepts relevant to probability and statistics such average, standard deviation and standard deviation of the mean. It addresses objectives found in the common core state standard. Our open source simulation was written in JavaScript and runs in any modern browser or tablet. It is available to the general public for free and has been translated in 17 languages.

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Poster Presentation)

Funded by Berea College URCPP

(2+1)-dimensional Causal Dynamical Triangulations. *Abdul Ali Elissar[1] and Joshua Cooperman[2].* [1]Physics Program, Berea College, Berea, Kentucky, 40404. [2]Bard College, Annandale-On-Hudson, New York, 12504.

We employ statistical methods to extract topological information from an ensemble of causally generated simplicial manifolds of a fixed topology. We use regular computer languages to transform an ensemble of causal triangulations, generated through a process named global hypersurface foliation, into effective one-dimensional graphs on which we calculate geometrical observables of quantum topological interest such as shortest distances, average distances, paths and cycles, and return probabilities.

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Poster Presentation)

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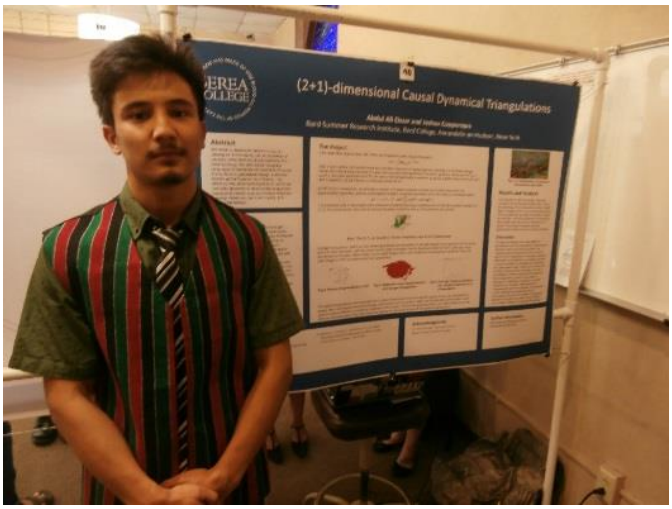

The CLAS12 Forward Tagger Detector at Jefferson Lab. *Talha Rehman[1] and Marco Battaglieri[2].*
[1]Physics Program, Berea College, Berea, Kentucky, 40404. [2]Jefferson Lab, Newport News, Virginia.

The CLAS12-Forward Tagger is designed to detect electrons produced by the interaction of CEBAF 11 GeV electron beam with the target. This detector is composed by an electromagnetic calorimeter (FT-Cal), based on lead tungstate scintillating crystals, a hodoscope (FT-Hodo), based on plastic scintillator tiles and two layers of Micromegas trackers (FT-Trck). The Forward Tagger is designed to measure electrons scattered between 2.5 and 5 degrees. Before the installation in the Hall-B of Jefferson Lab, the FT has been assembled in laboratory and is currently tested with cosmic rays. The calorimeter response is being measured to perform the energy calibration of the system. Cosmic rays crossing the calorimeter crystals release on average a fixed amount of energy that can be used to determine the absolute calibration of the system. The stability of system response can be monitored by studying the variation of calibration constants as a function of time. The results obtained in a few weeks of operation indicates that the energy response of the calorimeter is consistent with expectations and does not show significant time dependence.

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Poster Presentation)

Funded by Berea College Office of Internships

Thermo-Magnetic Properties of High Entropy Alloys. Tanner Thompson, Robert Barnes, Nathanael Bodine and Dr. Troy Messina. Physics Program, Berea College, Berea, Kentucky 40404.

This research is an effort to expand upon our understanding of magnetic high entropy alloys. The five-element alloys researched contain cobalt, chromium, iron, nickel, and another variant metal, M. The chemical makeup follows the formula CoCrxFeNiMy. While some of the magneto-caloric properties of these alloys have been theoretically mapped previously1, very little experimental data has been collected. Here we present results of structural and magnetic data on CoCr0.9FeNiAg0.2.

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Poster Presentation)

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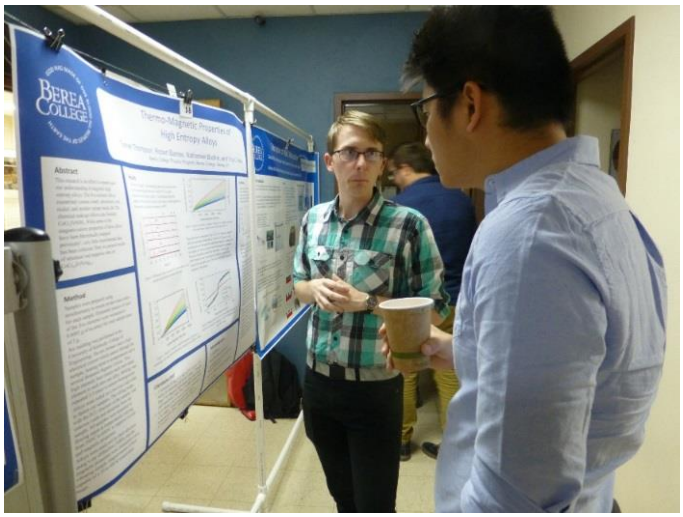


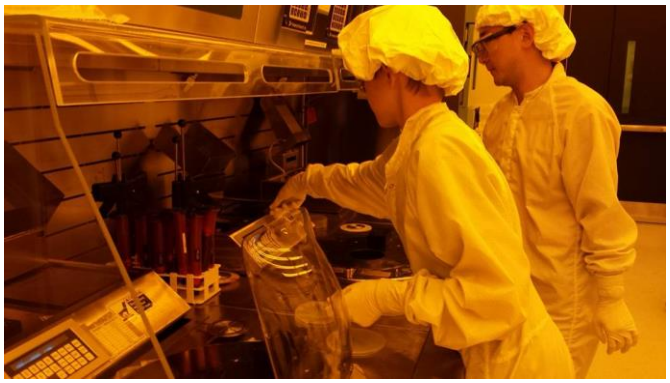
Fabrication of MEMS Microrobots. Dustin Watts[1] and Dan Popa[2]. [1]Physics Program, Berea College, Berea, Kentucky, 40404. [2]University of Louisville, Louisville, Kentucky, 40292.

Microrobots have been employed for many things in the 21st century and we all use the systems known as MEMS to aid us in our research and in our daily lives. The AFAM is a certain MEMS microrobot and it has been designed before and built. But the process can be repeated and it is done by following a recipe made by R. Murthy and it has to be completed in a cleanroom. The method was followed and over the time it took to get a fully released structure wafer, the process became more refined due to previous wafer runs not working. When fully released structures were obtained, time for the project ran out and the assembly of the robot was unable to be completed. Conclusions are that the structures are released, but they can be assembled in the near future if the research is continued.

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Poster Presentation)

102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Poster Presentation- Physics and Astronomy: 2nd place Undergraduate Research Competition)

Funded by IMPACT REU, University of Louisville



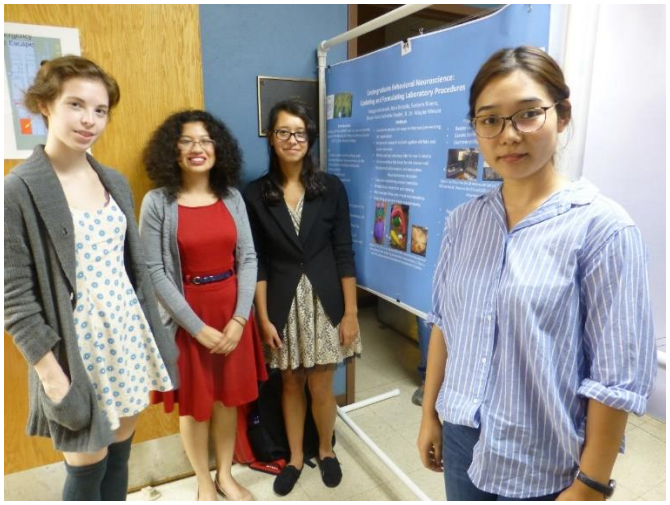
Undergraduate Behavioral Neuroscience: Updating and Formulating Laboratory Procedures.
Alicia Bedolla, Evelyne Rivera, Morgan Ketchersid, Tenzin Desel, Katherine Snyder and Wayne Messer. Psychology Program, Berea College, Berea, Kentucky, 40404.

The main focus of the undergraduate research was to create a method of teaching and learning behavioral neuroscience at the undergraduate level that is cost efficient, "hands on", Senjoyable, effective, and efficient. We looked at different ways that we could stain a sheep's brain that were not as bad for the environment as other stains are and that were cheaper alternatives. We also looked at different ways of building brain ventricles that would be affordable for most classes to use. The main point was to make the labs as affordable as possible so that any teacher could use these methods in their classroom.

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Poster Presentation)

102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Poster Presentation- Psychology: 1st Place Undergraduate Research Competition)

Funded by Berea College URCPP



Learning from Gesture: Do Catchments Enhance Learning? *Tiffany Estep[1], Sarah A. Brown[2], Andrea Marquardt Donovan[2] and Martha W. Alibali[2].* [1]Psycology Program, Berea College, Berea, Kentucky, 40404. *[2]University of Wisconsin-Madison,* Madison, Wisconsin, 53706.

Gestures are used regularly in classrooms to help communicate mathematical concepts (Goldin-Meadow, Kim, & Singer, 1999; Singer & Goldin-Meadow, 2005). Research has generally agreed that gestures play an important role in learning, but there is a lack of clarity in the literature about which gestures are the most effective at what times. This research focuses on a specific gesture situation called a catchment, which was proposed by David McNeill et al. (2001) to provide insight into the ideas of the speaker (i.e., instructors in this case). There is a lack of empirical research, however, on how catchments influence listeners (i.e., students). This research seeks to determine if observing catchments is beneficial to learners of a math concept, specifically the line model of multiplication. It was hypothesized that participants exposed to catchments would learn the most, followed by three other conditions, respectively: non-catchment, control, and anti-catchment. Undergraduate students from the University of Wisconsin-Madison (16 women and 37 men) watched a video lesson that corresponded with one of the four conditions, and then completed a packet of questions to assess their learning. Results indicated no significant differences in performance between groups and did not display the predicted trend; catchments did not lead to better performance. Future research should investigate this idea further with an adequate sample size and perhaps with different tasks and measures. Understanding which gestures are beneficial to learning would allow teachers to be more effective at communicating complicated mathematics topics.

102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Poster Presentation-Psychology)

Funded by Berea College Office of Internships

Calculating the Cost of Control: Locus of Control and Learning Abstract Math in the Face of Stereotype Threat. Tiffany M. Estep and Wendy R. Williams. Psychology Program, Berea College, Berea, Kentucky, 40404.

From 2002 to 2012, the percentage of women receiving doctoral degrees in mathematics remained about 28%, showing a stagnancy in the progression of women in the field of mathematics (National Science Foundation, 2013). This is partially explained by women's experience with stereotype threat, which states that stigmatized groups (i.e., women) within a domain (i.e., math) underperform on tasks in that domain when they are reminded that they belong to a stigmatized group. One previous study found that people with an external locus of control (LOC) are less vulnerable to stereotype threat (Cadinu, Maass, Lombardo, & Frigerio, 2006). Yet, individuals with an internal locus of control believe that their efforts determine their outcomes (Hammond & Rotter, 2012). This increased feeling of personal responsibility should increase vulnerability to stereotype. Thus, this study further investigates the relationship between stereotype threat and locus of control. Berea College students (26 women and 28 men) completed a survey to determine whether they had an internal or external locus of control. They then watched a video of an abstract math lesson and completed a math task using presented rules. There was no significant main effect of sex or LOC, nor an interaction. These results raise questions for future research, as this study disagrees with the previous study by Cadinu and colleagues (2006). This research is critical to understanding why women remain under-represented and continue to underperform in mathematics despite their ability to perform on the same level as men.

102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Oral Presentation- Psychology: 1st Place Undergraduate Research Competition)

Which Widget Would You Want? The Effects of Complexity, Consciousness, and Expertise on Decision Making. Valerie Zehr and Wendy R. Williams. Psychology Program, Berea College, Berea, Kentucky, 40404.

Decision making is an essential aspect of everyday living. Past research shows that unconscious processing can be more helpful than conscious processing for complex decisions—this is also true for experts in their field (Dijksterhuis, Bos, van der Leij, & van Baaren, 2009). The current research examined the effect of problem complexity, consciousness (conscious deliberation vs. unconscious processing), and expertise on decision making. It was hypothesized there will be main effects of complexity and expertise, no main effect of consciousness (due to other interactions), an interaction between complexity and consciousness, and between complexity and expertise. College students (N=35) were shown four objects of different values and asked to rank them. To manipulate complexity, some participants were given objects with nine characteristics whereas others were given objects with 20 characteristics. To manipulate consciousness, some trials involved ranking objects after being distracted, whereas others involved ranking objects after conscious deliberation. Participants became experts over the course of two sessions on two different days. Analyses showed a main effect of consciousness and expertise where conscious processing yielded better judgements than unconscious processing, and experts made better judgements than non-experts. There was a significant interaction between consciousness and expertise, where experts using unconscious and conscious processing performed similarly, and non-experts using unconscious processing did worse than either experts or non-experts using conscious processing. This research shows that overall conscious deliberation is better, except if someone is an expert. Experts processing unconsciously performed just as well as experts and non-experts who processed consciously.

102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Oral Presentation- Psychology: 2nd Place (Tie) Undergraduate Research Competition)

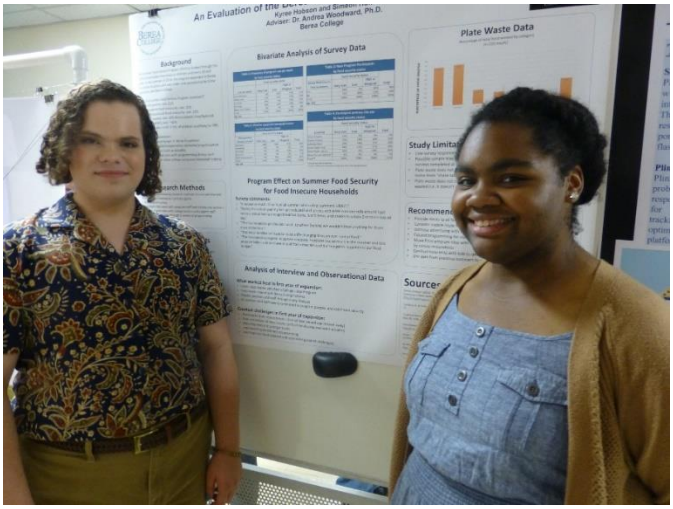
Evaluation of the Berea Summer Food Service Program. Kyree Hobson, Simeon Huff and Andrea Woodward. Sociology Program, Berea College, Berea, Kentucky, 40404.

This community-based research project evaluated the first summer of an expanded Summer Food Service Program (SFSP) in Berea under the sponsorship of Grow Appalachia and Berea College. The program expanded from one site to five in the summer of 2016 with five key goals: 1) to reduce childhood hunger over the summer months; 2) to reduce program stigma; 3) to use local and Kentucky Proud foods at the satellite sites; 4) to educate kids about nutrition, health, and local foods; and 5) to use lessons learned from the program to create a manual that can help other communities replicate the college-community partnership model. Research methods used to evaluate the program's progress toward these goals included participant observations, in-depth and focus group interviews, a household survey, and plate waste measurements. Key strengths of the program included a substantial increase in participation and committed and flexible program partners. Areas for growth in future summers include reducing plate waste, adjusting menus to respond tastes of children, using program data to more accurately predict demand, and finding ways to serve the hardest-to-reach families.

16th Annual Berea College Undergraduate Research Symposium, October 7th, 2016, Berea College, Berea, Kentucky (Poster Presentation)

102nd Annual Meeting of the Kentucky Academy of Science, November 4th-5th, 2016, University of Louisville, Louisville, Kentucky (Poster Presentation- Anthropology & Sociology: 1st Place Undergraduate Research Competition)

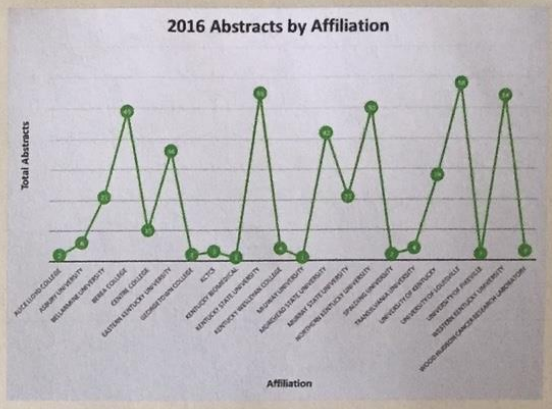
Funded by Berea College URCPP



APPENDIX

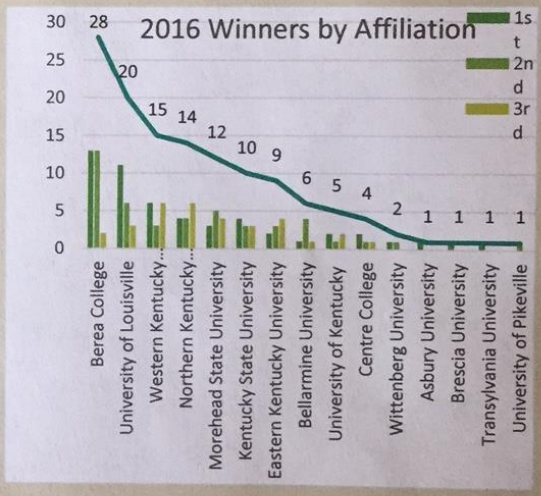
Annual Meeting Abstracts & Student Research Competition Awards

The number of abstracts the nineteen sections for our annual meeting was 442, up from our average 408.5. Of that number, there were 222 poster presentations and 220 oral presentations. For the undergraduate competition, there were 131 entered as poster presentations and ninety-four as oral presentations. In the graduate oral presentation competition there were sixty-four submissions. Four schools submitted more than fifty abstracts including Kentucky State University (55), NKU (50), WKU (54), and our host University of Louisville (58). (Table 1)



The Kentucky Academy of Science is divided into nineteen sections each with section officers, a section meeting, oral and poster presentations, and winners for graduate and undergraduate students. The top two sections for this year are Cellular & Molecular Biology (55) and Ecology and Environmental Sciences (50). (Table 2). As you see from Table 1, Cellular & Molecular Biology jumped from third largest to first over last year. Judges bestowed a total of 129 awards across the nineteen sections (Table 3). The institution with the most awards for 2016 is Berea College with a total of twenty-eight (13 first place, 13 second place, and 2 third place) awards. Our host, University of Louisville, is second with a total of twenty awards. Rounding out the top three is Western Kentucky University with fifteen awards. Please see the complete list of winners below. Congratulations to all of our winners and we look forward to seeing the next step of your research in Murray State. Check our website for a call for abstracts this fall.

Section	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	Average
Agricultural Sciences	39	37	37	32	36	35	30	37	35	34	29	34.6
Anthropology and Sociology	13	24	10	9	10	6	12	6	5	2	10	9.7
Botany	9	12	17	12	14	9	9	11	15	16	11	12.3
Cellular & Molecular Biology	55	41	36	41	27	22	39	33	28	30	29	34.6
Chemistry: A/P	15	31	30	25	69	60	79	64	60	35	70	48.9
Chemistry: O/I	33	44	44	42								40.8
Computer Information Sciences	21	18	8	17	3	10	17	10	8	10	14	12.4
Ecology and Environmental Sciences	50	59	58	60	33	27	32	34	28	50	31	42.0
Engineering	16	14	17	19	7	9	9	7	8	6	6	10.7
Geography	15	8	11	6	10	17	32	8	6	17	14	13.1
Geology	10	8	10	13	19	11	17	11	5	7	27	12.5
Health Sciences	23	11	25	17	11	12	17	15	17	20	19	17.0
Mathematics	14	10	8	14	4	5	12	13	5	8	9	9.3
Microbiology	28	18	26	16	11	10	30	17	15	14	12	17.9
Physics and Astronomy	25	31	16	29	29	21	22	24	25	23	28	24.8
Physiology and Biochemistry	26	31	35	40	35	25	14	25	25	24	19	27.2
Psychology	15	19	36	42	24	15	40	35	33	23	25	27.9
Science Education	17	14	20	23	14	6	16	11	9	12	18	14.5
Zoology	18	15	27	21	37	19	19	28	32	27	23	24.2
Total	442	445	471	478	393	319	446	389	359	358	394	408.5



Abstracts by Institution 2016

Alice Lloyd College 2
Georgetown College 2
Asbury University 6
KCTCS 3 Kentucky Biomedical 1
Bellarmine University 21
Kentucky State University 55
Berea College 49
Kentucky Wesleyan College 4
Brescia University 0
Lindsey Wilson College 0
Campbellsville University 0
Midway University 1
Centre College 10
Morehead State University 42
Eastern Kentucky University 36
Murray State University 21
Northern Kentucky University 50
Spalding University 2
Thomas More College 0
Transylvania University 4
University of Kentucky 28
University of Louisville 58
University of Pikeville 2
University of the Cumberlands 0
Western Kentucky University 54
Wood Hudson Cancer Research Laboratory 3

~~Total 454~~