2023

High Point University
Summer Research Program in the Sciences (SuRPS)
Final Research Symposium

Wanek School of Natural Sciences

Thursday, July 27 & Friday, July 28

Scenes from SuRPS…

2023 SuRPS KEYNOTE SPEAKER

"*Underappreciated & Underestimated: Implications of Human Fungal Pathogens and Genetic Approaches to Understanding Them*"

Dr. Calla Telzrow
(Department of Biology Class of 2016)

Senior Proposal Manager RFI at PPD, Part of Thermo Fisher Scientific

ABSTRACT

The fungal kingdom is an important contributor to ecosystems and society. Although humans have benefited greatly from fungal genetic diversity and phenotypic plasticity, these intrinsic features have enabled many fungi to evolve into human fungal pathogens with the ability to cause life-threatening disease, particularly in the immunocompromised. Despite the global burden of fungal disease on public health, funding is scarce, resulting in a limited understanding of fungal pathogenesis and few available tools to prevent and treat fungal disease. The Alspaugh laboratory at Duke University has worked for decades to better understand fungal pathogenesis through studies of *Cryptococcus neoformans*. Like many human fungal pathogens, *C. neoformans* is an environmental fungus that has evolved the ability to infect and cause disease in humans. Using genetic techniques, we have found that cell surface remodeling is an important adaptive cellular response employed by *C. neoformans* in the human host that promotes its pathogenesis. Upon colonizing and sensing the human host, *C. neoformans* changes the composition and organization of both its cell membrane and cell wall. This process enables *C. neoformans* to shield itself from host immune destruction, persist long-term in the human host, and cause serious disease if the human host becomes immunocompromised. Furthermore, we have found that these cell surface remodeling processes are driven by fungal-specific metabolic pathways, making them promising targets for antifungal therapies. Appreciation and understanding of fungal pathogens are essential as we move into an age with a growing immunocompromised population and new, emerging fungal pathogens.

BIO

Calla received a B.S. degree in Biology from High Point University in 2016. While there, Calla participated in the inaugural SuRPS program in Dr. Andrew Wommack's lab. She subsequently pursued her PhD in Molecular Genetics and Microbiology at Duke University under the direction of Dr. Andrew Alspaugh. Her thesis work harnessed genetic tools to study how the human fungal pathogen Cryptococcus neoformans adapts to the human host to survive and cause disease. In addition to this technical training, Calla benefitted from phenomenal mentorship throughout her graduate career which enabled her to explore many different scientific careers. Following the completion of her PhD in 2022, Calla joined the global contract research organization PPD, Part of Thermo Fisher Scientific. In her role as a Senior Proposal Specialist, Calla works with large teams of operational strategists, clinicians, and scientists to develop safe, streamlined, and cost-effective approaches for running clinical trials. Collectively, these experiences continue to shape her career philosophy, which she will discuss throughout her talk: A career is not a destination–each is a unique journey of learning and self-discovery.

SuRPS Final Symposium

(Thursday, July 27, 2023, Culp Planetarium, Wanek School of Natural Sciences)

Posters will be set up in the hall and lobby of the Wanek School of Natural Sciences. All posters should be set up by 9 am on Thursday for both poster sessions and will be taken down after the symposium completes on Friday after the Keynote Presentation.

Session I: Oral Presentations: Dr. Jeremy Whitson, Department of Biology, Presiding

	8:30 – 9:00		*COFFEE, TEA RECEPTION (WSNS Lobby)*
	9:00 - 9:05	Dr. Brian Augustine	Opening Remarks and Announcements
	9:05 – 9:15		Morning Poster Session Elevator Pitch Videos
Th.1	9:15 – 9:35	Emily Gillis	Use of Silane Self-assembled Monolayers to Inhibit Methicillin-resistant *Staphylococcus aureus* Biofilm Formation
Th.2	9:35 – 9:55	Hayes Bowman	Determining Plant Biochemical Responses to Pathogenic Stress: Insight Into Red Spots
Th.3	9:55 - 10:15	Sheridan Johnson	Is Delta-9 THC Neuroprotective?
Th.4	10:15 - 10:35	Tori Federico & Gabe Valenzano	Loratadine Influences MRSA Persisters
	10:40 - 11:00		*BREAK*

Session II: Poster Presentations Part A (11:00 am - 12:15 pm) (Wanek School of Natural Sciences Lobby)

- Ruth Augustine (Augustine / Lundin) “Use of Self-assembled Monolayers to Surface-initiate Polymerization of Poly(3-hexylthiophene) Onto Various Surfaces”
- Micayla Campbell (Hughes) “Characterizing Plant Biochemical Responses to Pathogenic Stress: Spotlight on Red Leaf Spots”
- Taylor Cox (Johnson) “Effects of Substrate and Structure on Performance of GaAsSb Near-infrared Core-Shell Nanowire Photodetectors”
- Teagan Graham (Fiser) “Design of Micropatterned Surfaces for Prevention of Bacterial Biofilm Growth”
- Jenny Ngo, Muneeba Zaman (Kuppinger) “Pilot Mountain Fire History”
- Elizabeth Rubeira (Whitson) “Investigating the Regulatory Changes in Urea Production and Transport Resulting from GSH Deficiency in the Eye Lens”
- Brett Sykes (Johnson) “Using MATLAB to Optimize the Energy Bands and Electric Fields of a n-i-p-i-p Nanowire Structure”
- Justus Young (Suh) “Melittin Inactivates Erk MAPK Pathway and Suppresses Invasion and Anchorage-independent Growth in Hs578t Cells”

12:15 – 1:20 *LUNCH BREAK*

(Note: Thursday, July 27 afternoon sessions continued on next page)

Session III: Oral Presentations: Dr. Sean Johnson, Department of Electrical Engineering, Presiding

	1:30 – 1:40		Afternoon Poster Session Elevator Pitch Videos
Th.5	1:40 - 2:00	Marie Streng	Melittin May Induce Multiple Types of Programmed Cell Death in Triple Negative Breast Cancer Cells
Th.6	2:00 – 2:20	Madison Hill	Impact of Ultraviolet Light on Aggregation-induced Fluorescence of Rhodamine B Amide Derivatives
Th.7	2:20 - 2:40	Alyson Acquard	Taxonomic Trends in Anatomical Distribution of Red Pigments in Autumn Leaves
Th.8	2:40 – 3:00	Nadia Khan & Parker Nyboer	Expression, Purification, and Characterization of Carbonic Anhydrases From Extremophiles
	3:10 – 3:15		*BREAK*

Session IV: Poster Presentations Part B (3:15 - 4:30 pm) (Wanek School of Natural Sciences Lobby)

- Nadia Khan (Kean) “Expression, Purification, and Characterization of a Novel Carbonic Anhydrase from *Hypsibius exemplaris* (HeCA)”
- Jack Quintana (Rudock) “Monitoring the Endangered Cape Fear Shiner (*Notropis mekistocholas*) Presence in the Cape Fear River Basin Using Environmental DNA”
- Elijah Sage (Rudock) “Demystifying EVs: Increasing Accessibility to a Precious Regenerative Medicine Resource”
- Marie Streng (Suh) “Melittin May Induce Multiple Types of Programmed Cell Death in Triple Negative Breast Cancer Cells”
- Levi Wenger (Johnson) “Using COMSOL Multiphysics to Simulate Photodetector Nanowires to Obtain IV Curves, Electric Field, and Carrier Concentration”
- Anaiya Whitaker (Grider) “Testing the Neuroprotective Effects of Ashwagandha”
- Darryl Wright (Fogarty) “Cyclic Voltammetry Investigation of Redox Chemistry of Rhodamine B Amide Derivatives”
- Toheed Zaman (Wommack) “4-Phenylbutyrate Promotes Mitochondrial Biogenesis and Metabolism in C2C12 Myotubes While Increasing Extracellular BCAA Concentrations During Insulin Resistance”

SuRPS Final Symposium

(Friday, July 28, 2023, Culp Planetarium, Wanek School of Natural Sciences)

Session V: Oral Presentations: Dr. Kelsey Kean, Department of Chemistry, Presiding

	8:30 - 9:00		*COFFEE, TEA RECEPTION (WSNS Lobby)*
Fr.1	9:00 - 9:20	Robin Stempel	Transcriptomic Analyses of Multiple Antibiotic Adjuvants Against MRSA
Fr.2	9:20 - 9:40	Billy Hayden	Quantifying Post-Translational Modifications in Young to Aged Rhesus Macaque Lenses
Fr.3	9:40 - 10:00	Erik Peterson, Garrett Laws & Jake Morgan	Modeling Glutathionylation by Installing a Redox-Inert Surrogate Using the Thiol-Ene Coupling Reaction
Fr.4	10:00 - 10:20	Esprit Cha	First Steps Towards Developing a Fire History for Hanging Rock State Park
Fr.5	10:20 - 10:40	Taylor Cox, Levi Wenger, & Brett Sykes	Investigating Design Parameters and Performance of GaAsSb Near-infrared Core-shell Nanowire Photodetectors
	10:40 - 11:00		*BREAK*

Keynote Address: (Introduction by Dr. Andrew Wommack, Department of Chemistry)

11:00 am – 12:00 pm

Calla Telzrow, Ph.D.
(HPU Class of 2015)
RFI at PPD

"Underappreciated & Underestimated: Implications of Human Fungal Pathogens and Genetic Approaches to Understanding Them"

Lunch at Café / Lab Clean Up

Special Thanks:

Dr. Joanne Altman, Director HPU Undergraduate Research and Creative Works Program
Rebecca Smoak, Biology, Chemistry and Physics Administrative Assistant extraordinaire
Betsy Warner, WSNS Administrative Assistant
Wanek School of Natural Sciences and High Point University for financially supporting the SuRPS Program
The WSNS Natural Science Fellows Program
Dr. Pamela Knippenberg, Chemistry Department Lab Manager
Luke Dixon, Biology Department Lab Manager
Erin Brady, Physics Department Lab Manager
Dr. Brad Barlow and Culp Planetarium for symposium support
Pam Haynes, Cinde Ingram, Lee Adams HPU Office of Communications

STUDENT ABSTRACTS ORAL PRESENTATIONS:

{Note: presenting author(s) is underlined, * denotes faculty advisor(s)}

(Th.7) Taxonomic Trends in Anatomical Distribution of Red Pigments in Autumn Leaves

Alyson Acquard, David W. Lee, J. Mason Heberling, Howard S. Neufeld, Campbell O. Webb, and Nicole Hughes*
Department of Biology, High Point University

Red anthocyanin and betacyanin pigments are produced by many species during autumn in the temperate zone. However, it remains unclear why certain species produce red pigments and others do not. Furthermore, very few researchers have surveyed the anatomical location of red pigments in autumn leaves. This research is part of a large collaborative project working to understand the taxonomic and anatomical patterns of anthocyanin distribution in autumn leaves. Red autumn leaves of nearly 300 species of herbs, shrubs, and trees were sampled at 13 field sites spanning Alaska to Florida. Fresh leaves were sectioned and viewed with a light microscope, and the anatomical location of red pigments was scored (i.e., presence/absence in upper epidermis, palisade mesophyll, spongy mesophyll, and/or lower epidermis). We present here examples of taxonomic trends in anthocyanin histology observed in this study.

(Th.2) Determining Plant Biochemical Responses to Pathogenic Stress: Insight Into Red Spots

Hayes Bowman, Micayla Campbell, and Nicole Hughes*
Department of Biology, High Point University

Red leaf spots commonly accompany pathogen infection in plants. Yet, the function of red anthocyanins pigments in infected tissues is unknown. The objective of our research was to test two possible functions of anthocyanins in red spots: photoprotection and antimicrobial defense. Previous SUPRS students used analytical HPLC and LC-MS to identify and quantify anthocyanins in red spots, and compared them to those of other red tissues on the same plant, as well as in green tissues (green areas around red spots, fully-expanded green leaves). In order to determine whether anthocyanins played a major role in photoprotection, they measured maximum quantum yield efficiency of PSII (Fv/Fm) using a fluorometer, and xanthophyll cycle pigment ratios using HPLC. This summer, we additionally quantified antioxidant activity in red spots compared to the surrounding area using DPPH radical scavenging assay. Furthermore, we tested whether anthocyanins played a role in antimicrobial defense by inoculating spores of *Entomosporium mespili* (the cause of red spots in Photinia) in potato dextrose agar containing either: water only, cyanidin-3-O-galactoside (the major anthocyanin in Photinia), one of two osmotic controls--CsCl (cesium chloride) or KCl (potassium chloride), or a sugar control--galactose. Our collective results support a photoprotective function of anthocyanins. First, the anthocyanins profiles in red spots were identical to those of other light-sensitive tissues on the plant (i.e., fruits, flowers, peduncles, expanding leaves, senescing leaves, petioles, stems, and apical buds), rather than unique to the red spot. Additionally, all red tissues had significantly lower chlorophyll and Fv/Fm than green tissues, suggesting increased vulnerability to photo-oxidative stress. Photoprotective carotenoids did not differ between red and green tissues, likely due to small sample size. Finally, antioxidant activity was 14-22% higher (variation depending on light intensity) in red spots versus surrounding green tissues; preliminary assays with purified anthocyanins suggested anthocyanins were responsible for ca. 1/3 antioxidant activity in red spots. Preliminary results from anti-microbial experiments showed that anthocyanins inhibited *E. mespili* germination more than water control, but not as much as KCl. Experiments testing additional controls are currently underway.

(Fr.5) Investigating Design Parameters and Performance of GaAsSb Near-infrared Core-shell Nanowire Photodetectors

Taylor Cox, Brett Sykes, Levi Wenger, and Sean Johnson*
Department of Electrical Engineering, High Point University

Near-infrared nanowire (NW) photodetectors are used in a variety of light-sensing technologies such as telecommunications, fiber optics, and medical imaging. However, NWs are a relatively novel area of research, and many performance-affecting parameters have yet to be fully understood. Literature review, data analysis, and mathematical modeling are conducted to examine SACM avalanche and n-i-p NW photodetectors; i-region thickness; material composition; axial, core-shell, and hybrid structures; substrate properties; negative capacitance; doping concentration; electric field; energy band gap; and carrier transport mechanisms; as well as the intertwined behavior of these aspects. The assessment of I-V, C-V, and noise data shows potential solutions for an optimized NW through the enhancement of its structure and substrate selection. Analysis of conventional and hybrid core-shell NW structures through MATLAB calculations and COMSOL simulations is also demonstrated.

(Fr.4) First Steps Towards Developing a Fire History for Hanging Rock State Park

Esprit Cha, Jenny Ngo, Muneeba Zaman, and Dane Kuppinger*
Department of Biology, High Point University

Fire is a necessary disturbance in certain habitats to maintain canopy and understory growth and assist with the repopulation of pyrogenic vegetation. The presence of fire-adapted and fire-dependent pine species at Hanging Rock State Park (HRSP), located in North Carolina's Piedmont region, suggests a history of fire. As a first step towards developing a fire history for HRSP, this study assessed which areas of the park contained fire-adapted plant communities, measured specific topographic conditions where these species reside, and identified locations where additional surveys are needed. Field surveys were used to validate current vegetation community maps and initial samples containing fire scars were collected for analysis. ArcGIS was used to identify the slope, aspect, and elevation of a series of random points constrained within the park boundaries. These values were compared to the respective values constrained within the pine-oak heath vegetation boundaries. Pine-oak habitats were found on significantly steeper slopes ($p=0.0027$) than the average slopes for HRSP overall. Pine-oak habitats were also on significantly higher elevations ($p=0.0027$) than average for HRSP. Pine-oak habitats were most abundant on southern aspects and least abundant on eastern aspects. This contrasts with the park overall, which was comprised of largely northern aspects and was minimally comprised of western aspects. Certain areas of the pine-oak habitat were surveyed extensively, but additional surveys of these areas should be carried out in tandem with surveys outside of the provided pine-oak habitat. Pine samples were found in surrounding Chestnut Oak and Carolina Hemlock forest communities. Additional studies at HRSP can develop a nuanced understanding of the area's current and past vegetation, informing future management practices on how to maximize the health of the area's ecosystem.

(Th.4) Loratadine Influences MRSA Persisters

Tori Federico, Gabe Valenzano, Meghan S. Blackledge, and Heather B. Miller*
Department of Chemistry, High Point University

Methicillin-resistant *Staphylococcus aureus* (MRSA) is a major human pathogen. MRSA encodes defense mechanisms that generates resistance to ß-lactam antibiotics. Antibiotic adjuvants offer an alternative to new antibiotics, as bacteria cannot acquire resistance to antibiotic adjuvants. Loratadine serves as an antibiotic adjuvant in vitro. To gain insight into how loratadine exerts its effects, we measured differential gene expression via transcriptomics. Many ribosomal genes decreased in expression with loratadine or oxacillin alone and were partially restored to control levels when cotreated. It is possible that this was ribosomal downregulation as bacteria become dormant and that loratadine and oxacillin cotreatment thwarts those efforts, shifting bacteria into a more metabolically active state that allows the antibiotic to be effective again. Subpopulations of bacteria (called persisters) can survive cellular stress by entering this dormant state. We hypothesized that loratadine increases persisters in MRSA. To test this hypothesis, experiments compared stationary persisters of untreated MRSA 43300 cells to loratadine treated cells. Additionally, intracellular ATP levels were measured. This revealed that loratadine increased the number of persisters by approximately 2-fold. Loratadine decreased ATP levels, supporting our hypothesis. However, oxacillin and cotreated cells did not follow the same trend as the ribosomal gene expression. This is consistent with the fact that protein synthesis is only one metabolic pathway influencing ATP levels. Additional persister experiments will be presented on loratadine cotreatment and pretreatment before antibiotic challenge, as well as protein translation measurements. Ultimately, this data will add to the understanding of loratadine's effects as an antibiotic adjuvant in MRSA.

(Th.1) Use of Silane Self-assembled Monolayers to Inhibit Methicillin-resistant *Staphylococcus aureus* Biofilm Formation

Emily Gillis and Pamela Lundin*
Department of Chemistry, High Point University

As bacteria continue to grow resistant to antibiotic treatment, methicillin-resistant *Staphylococcus aureus*, or MRSA, has become an imminent problem in the healthcare field. When MRSA forms a biofilm, it becomes even more resistant to antibiotics, becoming up to 1000 times more resistant than planktonic bacteria. Silicone-based devices are highly used in the medical industry, but any time one is used, there is a risk for bacterial infections and subsequent biofilm growth. We have investigated a method for inhibiting the formation of MRSA bacterial biofilms by chemically functionalizing the surface of polydimethylsiloxane, a silicone elastomer, with self-assembled monolayers of 3-aminopropyltriethoxysilane (APTES) and 11-aminoundecyltriethoxysilane (AUTES). Bacteria are added to functionalized PDMS and incubated for 24 hours, resulting in observable biofilm formation. MRSA strains 43300, USA100, and USA300 have been tested and inhibition has been examined using crystal violet assays and colony-forming unit counts.

(Fr.2) Quantifying Post-Translational Modifications in Young to Aged Rhesus Macaque Lenses

Billy Hayden[1], Larry David[2], Ashok Reddy[2], and Jeremy Whitson*[,1]
[1]Department of Biology, High Point University
[2]Oregon Health & Science University, Portland, OR

As organisms age, the body's systems become increasingly dysregulated, resulting in damages that degrade the organism's function and fitness. One of the many changes that organisms go through is the ability to regulate and maintain protein structure. Over time, proteins develop post-translational modifications; changes to the protein structure that have previously been linked to several age-related pathologies. The lens has one of the most unique physiological structures in the natural world. As cells of the lens mature, they kill off all their organelles in order to reach transparency, leaving behind primarily crystallin proteins, which help to refract incoming light and focus it on the retina. These proteins never get broken down or replaced, making the lens an excellent model to study age-related post-translational modifications in long-lived proteins. Using the cores of lenses from young (~4 years old) and aged (12-20 years old) wild Rhesus macaques, we collected these long-lived lens proteins. These proteins were then separated into water soluble and water insoluble fractions, in order to help us understand what types of modifications are most damaging to protein structure and function. Utilizing cutting edge proteomics technology, we are now investigating the types of modifications that are accumulating with age, giving us a deeper insight into the nature of biological aging at the molecular level.

(Th.6) Impact of Ultraviolet Light on Aggregation-induced Fluorescence of Rhodamine B Amide Derivatives

Madison Hill, Pamela Lundin*, and Keir Fogarty*
Department of Chemistry, High Point University

Rhodamine B is a xanthene dye with many optical properties, leading it to be used in a variety of fields. In prior research, our lab has explored the optical behaviors of rhodamine B amide derivatives. Rhodamine B amides have two forms, an open form, and a closed form. In most solvent environments, rhodamine B amide derivatives favor their closed form, and aggregation-induced blue fluorescence is observed. Previous research has shown that rhodamine B amide derivatives exposed to ultraviolet light undergo ring opening, with the open form exhibiting bright orange fluorescence. We wanted to see if ultraviolet light would have an impact on the blue fluorescence caused by aggregation. Our research indicates that ultraviolet light does reduce the aggregation-induced blue fluorescence, implying ultraviolet light changes the solubility of rhodamine B amide derivatives.

(Th.3) Is Delta-9 THC Neuroprotective?

Sheridan Johnson and Michael Grider*
Department of Biology, High Point University

Traumatic Brain Injury (TBI) -related emergency visits have increased by 70% over the last decade, yet there are no FDA approved treatments that specifically target neuroprotection. Following a brain injury, Reactive Oxygen Species (ROS) are produced, resulting in apoptosis of neural cells. To model TBI in vitro, we administered Hydrogen Peroxide to induce apoptosis in otherwise healthy neuronal SH-SY5Y cells. Recent data demonstrates that several cannabinoids can act as efficient antioxidants. We hypothesize that the use of Delta 9 tetrahydrocannabinol (THC) in this experiment will attenuate cell death. Several different concentrations of THC were tested and cell viability was measured through MTT assays. We found that, even at high concentrations, THC did not decrease cell viability, suggesting that THC is not neurotoxic. Preliminary results provided no evidence that the administration of THC protects cultured neurons against oxidative injury.

(Th.8) Expression, Purification, and Characterization of Carbonic Anhydrases from Extremophiles

Nadia Khan, Parker Nyboer, and Kelsey M. Kean*
Department of Chemistry, High Point University

Carbonic anhydrases (CAs) are a family of metalloenzymes that catalyze the conversion of water and carbon dioxide to bicarbonate and protons. CAs are found in all domains of life and serve multiple regulatory roles, for example maintaining blood pH in humans. The chemistry that CAs perform has applications in industry such as CO_2 capture and biomedical applications such as artificial lungs. However, these uses often place CAs in harsh conditions for most proteins. As such, CAs from extremophiles could be a solution to protein denaturation under said conditions. We have identified putative β carbonic anhydrases from the extremophile bacterium *Deiniococcus radiodurans* (DrCA) and the tardigrade *Hypsibius exemplaris* (HeCA). *D. radiodurans*' radiation resistance is one of the strongest known among all organisms, and tardigrades are widely known to survive harsh environments, including the vacuum of space. Here, we report the successful expression, purification, and characterization of DrCA and HeCA. We utilized a colorimetric and pH-based assay to characterize CA activity. In the future, we propose to further optimize purification conditions and continue to test the ability of these enzymes to function efficiently under harsh conditions.

(Fr.3) Modeling Glutathionylation by Installing a Redox-inert Surrogate Using the Thiol-Ene Coupling Reaction
Erik Peterson, Garrett Laws, Jake Morgan, Toheed Zaman, and Andrew J. Wommack*
Department of Chemistry, High Point University

Glutathionylation is an important redox reaction that conjugates a thiol group from glutathione (GSH) to cysteine-containing biomolecules. This process buffers oxidative stress within the cell, prevents overoxidation of thiols, and can mediate protein folding. To further study this reaction, we prepared alkene-containing glutathione derivatives in order to install a redox inert thioether, which serves as a bioisostere of the native disulfide bond. A diverse array of model peptides was synthesized to mimic proteins and enzymes that are known to undergo glutathionylation. Following the optimization of the thiol-ene coupling (TEC) reaction conditions, the glutathionylation of these model peptides was observed and analyzed. Solid-phase peptide synthesis was used to prepare the small library of peptides which participated in the TEC reactions. The monitoring of the reaction was conducted using Shimadzu analytical high-performance liquid chromatography (HPLC) and purified by Agilent preparative HPLC. Using Fmoc-based peptide coupling techniques, we plan to synthesize glutathione derivatives for further evaluation.

(Fr.1) Transcriptomic Analyses of Multiple Antibiotic Adjuvants Against MRSA
Robin Stempel, Halie Balogh, Brianna Viering, Meghan S. Blackledge, and Heather B. Miller*
Department of Chemistry, High Point University

Serine/threonine protein kinase (Stk1) is a key protein involved in the biosynthesis of the gram-positive bacterial cell wall. It has been shown to play a key role in antibiotic resistance in methicillin-resistant *Staphylococcus aureus* (MRSA). Adjuvants are compounds that do not kill bacteria, but when coupled with antibiotics sensitize the bacteria to those antibiotics. This study investigates the antibiotic adjuvant functions of compound 8 and loratadine. These two compounds are structurally related and considered lead antibiotic adjuvants in our lab. We hypothesized that these adjuvants inhibit the kinase activity of Stk1. We took a transcriptomic approach to learn more about what these adjuvants do at the molecular level. RNA sequencing was performed on MRSA lab strain 43300 and it showed a decrease in stk1 gene expression in loratadine treated samples. The same trend was found with its corresponding phosphatase, stp1. There were not significant changes with compound 8 treated samples. To support these findings from RNA sequencing, RT-qPCR was utilized as a complementary method and validated those changes. We are also reporting a novel small RNA that was discovered showing regulation by loratadine. We expanded our analyses to clinically relevant MRSA strains, USA100 and USA300. These are the most prevalent hospital and community acquired strains, respectively, in the United States. The levels of stk1 and stp1 were not affected by either antibiotic adjuvant tested in these two strains. We will present additional preliminary data, adding to our knowledge of the antibiotic adjuvants functions across multiple MRSA strains.

(Th.5/P.12) Melittin May Induce Multiple Types of Programmed Cell Death in Triple Negative Breast Cancer Cells
Marie Streng, Justus Young, and Y. Kevin Suh*
Department of Biology, High Point University

Programmed cell death (PCD) is also known as regulated cell death and is an essential process in living organisms. Unlike accidental cell death (ACD) which is an uncontrolled cell death and triggered by accidental injury stimuli, PCD occurs under physiological conditions and plays a vital role in homeostasis maintenance. The currently known types of PCD include autophagic cell death, necroptosis, ferroptosis, pyroptosis, and apoptosis, which is also known as “cellular suicide”. Triple negative breast cancer is characterized by the lack of estrogen receptor, progesterone receptor, and epidermal growth factor receptor 2 (EGFR2/HER2) expression. Therefore, they are not sensitive to common treatments such as hormone therapy and anti-EGFR2 drugs, and this subtype of breast cancer is considered more aggressive than other types of breast cancer. Melittin is an amphipathic polypeptide with 26 amino acids and a major component of bee venom. Previously, we have shown that melittin inhibits viability and migration of Hs578t triple negative breast cancer cells using MTS assay and Ibidi plates, respectively. In the present study, we investigated the possible mechanism of programmed cell death in melittin treated Hs578t cells using Western blotting, DNA fragmentation, and proluminescent caspase assay.

STUDENT ABSTRACTS POSTER PRESENTATIONS:

{Note: presenting author is underlined, * denotes faculty advisor(s)}

THURSDAY, JULY 27 POSTER SESSION A (11:00 – 12:15 pm):

(P.1) Use of Self-assembled Monolayers to Surface-initiate Polymerization of Poly(3-hexylthiophene) Onto Various Surfaces

Ruth Augustine, Brian H. Augustine*, and Pamela M. Lundin*
Department of Chemistry, High Point University

Conjugated polymer brush (CPB) films have many applications with the most prominent being in the field of organic semiconducting devices. Self-assembled monolayers (SAMs) are molecular assemblies that adhere to a surface through adsorption forming a covalent linkage with the surface. Through this work, we are using SAMs as a method to attach and grow conductive polymer thin films directly from a surface. Previous experiments in our lab have demonstrated that CPB films of poly(3-hexylthiophene) or P3HT can be grown successfully from a Si or Au-coated Si surface using ω-aminoalkylsilane SAMs as a templating layer. In this study, we are extending the prior work to include P3HT polymerization from SiO_2 oxidized Si wafers as well as using microcontact printing (μ-CP) to produce sub 1 μm polymer features. We are using polydimethylsiloxane (PDMS) stamps prepared from a delaminated compact disc surface, which has 750 nm lines and spaces, as the master. Eicosanethiol (ECT) is pipetted onto the PDMS stamp before being transferred to a Au coated Si substrate. The methyl-terminated μ-CP ECT stripes act as a region blocking the self-assembly of the polymer-initiating SAM. The P3HT polymer is subsequently grown from the prepatterned templating layer. We will report on the characterization of the different resulting surfaces using X-ray photoelectron spectroscopy (XPS), infrared (IR) spectroscopy, contact angle, scanning electron microscopy (SEM), and atomic force microscopy (AFM).

(P.2) Characterizing Plant Biochemical Responses to Pathogenic Stress: Spotlight on Red Leaf Spots

Micayla Campbell, Anna Ferraro, Maggie Salley, Hayes Bowman, and Nicole Hughes*
Department of Biology, High Point University

The function of red anthocyanins pigments in infected tissues is unknown. We characterized biochemical responses of Indian hawthorn (*Rhaphiolepis indica*) to infection by the pathogenic fungus, *Entomosporium mespili*. We used analytical HPLC and LC-MS to identify and quantify anthocyanins and photopigments in red leaves or tissues (including expanding leaves, senescing leaves, and red spots) and green tissues (areas around red spots, fully expanded green leaves) of the same plants. Maximum quantum yield efficiency of PSII (Fv/Fm) and xanthophyll cycle pigment ratios was measured as a proxy for sustained high-light stress. DPPH radical scavenging assay assessed low molecular weight activity (LMWA) in red spots versus surrounding green tissues. The major anthocyanins in red tissues of both species were cyanidin-3-O-galactoside and cyanidin-3-O-arabinoside. Red tissues of Indian hawthorn also contained small amounts of three additional cyanidin mono-glycosides and lacked cyanidin-3-O-arabinoside. All red tissues had significantly lower chlorophyll and Fv/Fm than green tissues, suggesting increased vulnerability to photo-oxidative stress. Photoprotective carotenoids did not differ between red and green tissues, likely due to small sample size. Antioxidant activity was 1.5-3.4x higher in red spots versus surrounding green tissues; follow up assays with purified anthocyanins suggested anthocyanins were responsible for ca. 1/3 antioxidant activity in red spots. From these results, we predict the function of anthocyanins in red spots is similar to anthocyanins in young and senescing leaves, and this function likely includes photoprotection (i.e. light attenuation and antioxidant defense). We are currently investigating an anti-microbial function by culturing *Entomosporium mespili* in water agar plates treated with cyanidin-3-O-galactoside. Optimal conditions are being determined to avoid anthocyanin degradation.

(P.3) Effects of Substrate and Structure on Performance of GaAsSb Near-infrared Core-shell Nanowire Photodetectors

Taylor Cox, Brett Sykes, Levi Wenger, and Sean Johnson*
Department of Electrical Engineering, High Point University

Near-infrared nanowire (NW) photodetectors are used in a variety of light-sensing technologies such as telecommunications, fiber optics, and medical imaging. Novel design choices, such as hybrid axial core-shell structure and graphene substrate, have garnered interest due to the potential for better photoresponse, but the dependence of their behavior on specific parameters has yet to be fully understood. Literature review and analysis of I-V, C-V, and noise data provide a window into the advantages and unintended effects of these characteristics. Potential solutions are presented to combine the benefits of new research while avoiding problems identified in existing data.

(P.4) Design of Micropatterned Surfaces for Prevention of Bacterial Biofilm Growth

Teagan Graham and Briana Fiser*
Department of Physics, High Point University

In recent years, bacteria have become increasingly resistant to antibiotics. Additionally, indwelling medical devices (IMD) like catheters have an increased risk of infection, since they can create a path from the outside of the body to the inside for bacteria to grow. Since IMDs are used to support the body when it cannot support itself, research has focused on how to inhibit or kill bacteria growth on their surfaces. Bacteria attach to surfaces by creating a biofilm, which is difficult to remove after formation. One technique to prevent initial bacterial attachment and to see a decrease in biofilm formation is the patterning of surfaces with micrometer-sized engineered features on them. Our research is to determine how feature sizing, spacing, shape, and surface roughness affect biofilm growth on surfaces. The patterns are designed using CAD software and a master is fabricated on a silicon wafer using photolithography, which is later copied to create polydimethylsiloxane (PDMS) surfaces. Bacteria is then cultivated on these PDMS surfaces. It is through this process that we hope to find the shape and dimensions that provide the highest resistance to biofilm growth.

(P.5) Pilot Mountain Fire History

Nhu Ngo, Muneeba Zaman, Esprit Cha, and Dane Kuppinger*
Department of Biology, High Point University

Fire plays a significant role in some ecosystems; stimulating new growth, enhancing wildlife habitat, and reducing fuel thereby preventing high intensity wildfires. Over time, there have been changes in how people view fire, there are three time periods in which fire management practices have been divided into: Pre-suppression (1826-1929), Suppression (1930-1980), and post-suppression (1981-2022). The objective of this research was to expand our understanding of the Piedmont's fire history as recorded by fire scarred pines at Pilot Mountain State Park. Fire scars contained within tree cross-sections were analyzed to create a fire history for the park and to calculate how fire frequency, as measured by composite Mean Fire Interval (MFI) and Weibull Median Interval (WMI) and Decadal Fire Index (DFI), and seasonality changed with different fire management periods. Fire frequency declined significantly from the Pre-suppression to the Suppression period ($p<0.01$, Tukey HSD post-hoc test), but was not significantly different from the Suppression to Post-suppression period. ($p>0.05$, Tukey HSD post-hoc test). These results indicate that current management practices have increased the fire frequency since the Suppression period, however, they are still not near the Pre-suppression fire frequency. Having this fire history record will aid park management in prescribing fire regime.

(P.6) Investigating the Regulatory Changes in Urea Production and Transport Resulting from GSH Deficiency in the Eye Lens

Elizabeth Rubeira, Billy Hayden, Jack Quintana, and Jeremy Whitson*
Department of Biology, High Point University

The Lens Glutathione (GSH) Synthesis KnockOut (LEGSKO) mouse was engineered as a model of lens GSH deficiency for use in cataract research. In a study analyzing the concentration of urea in the lens and how urea transport occurs within the lens, it was discovered that GSH deficiency led to higher export of urea in LEGSKO mouse lenses in comparison to wildtype lenses. To determine what caused this change, LEGSKO and loxP (wildtype) mouse lenses were dissected into capsule, cortical fiber, and nuclear fiber regions. These tissue samples were prepared into aliquots to perform various Western blots. These Western blots were performed to test the presence and abundance of urea transporters and enzymes involved in the urea cycle to try and determine what process affected by GSH deficiency led to the higher export of urea in the LEGSKO mouse lenses. A quantitative analysis was done on the blots to determine whether there was any statistical difference in the amount of each transporter or enzyme between the groups (capsule, cortex, and nucleus) or between the two lens types (LEGSKO and loxP). The current data suggest that there is a statistical difference in one isoform of urea transporter B (UT-B) between the LEGSKO and loxP lenses. This higher abundance of the UT-B 35kDa isoform may explain why urea is exported at a greater rate in the LEGSKO mouse lenses that are deficient in GSH in comparison to the wildtype mouse lenses.

(P.7) Using MATLAB to Optimize the Energy Bands and Electric Fields of a n-i-p-i-p Nanowire Structure
Brett Sykes, Levi Wenger, Taylor Cox, and Sean Johnson*
Department of Electrical Engineering, High Point University

Avalanche photodiodes (APDs) absorb photons, creating an electron-hole pair, using impact ionization to collide with more electrons creating an avalanche effect. A strong electric field is required for this process and is amplified through acceptor and donor doping (N_a and N_d) for the p and n regions respectively. Using Poisson's equation, it is possible to predict the electric field and energy band gap, which in turn gives the built-in potential voltage (V_{bi}) that is required for electrons to cross over the i-region in a n-i-p-i-p core-shell nanowire (NW) structure. Through MATLAB code, calculations are expedited and the separation-absorption-charge-multiplication (SACM) process is clearly shown to occur. Ultimately, this creates an easy design approach for creating new and more optimal APD NW configurations.

(P.8) Melittin Inactivates Erk MAPK Pathway and Suppresses Invasion and Anchorage-independent Growth in Hs578t Cells
Justus Young, Marie Streng, and Y. Kevin Suh*
Department of Biology, High Point University

The Erk/mitogen-activated protein kinase (MAPK) is a serine/threonine protein kinase involved in many cellular programs, such as cell motility, proliferation, differentiation, and survival. Erk/MAPK signaling pathway can be activated in response to a diverse range of extracellular stimuli such as growth factors. Upon activation, Erk can regulate its targets in the cytosol and also translocate to the nucleus where it regulates expression of its target genes via phosphorylation of transcription factors. Therefore, Erk/MAPK pathway is considered an important target in the diagnosis and treatment of cancer. One of the hallmarks of cancer is that the neoplastic cells are able to survive and grow in the absence of anchorage. Therefore, anchorage-independent growth assay in soft agar is a valuable in vitro assay for measuring the proliferation of transformed cells. The invasion ability of cancer cells can be quantified by growing the cells in a Boyden chamber with a porous membrane coated with Matrigel that represents extracellular matrix. When Hs578t breast cancer cells were treated with melittin, we observed decreased expression of phosphorylated Erk. Anchorage independent growth and invasion through the Matrigel of Hs578t cells were significantly decreased upon treatment with melittin.

THURSDAY, JULY 27 POSTER SESSION B (3:15 – 4:30 pm):

(P.9) Expression, Purification, and Characterization of a Novel Carbonic Anhydrase from *Hypsibius exemplaris* (HeCA)
Nadia Khan, Parker Nyboer, and Kelsey Kean*
Department of Chemistry, High Point University

Carbonic anhydrases (CAs) are the catalysts for a chemical reaction that produces hydrogen and bicarbonate ions from water and carbon dioxide. CAs serve important functions in human physiology which is seen in blood pH and bone resorption. CAs are used for industrial applications such as CO_2 capture, and biomedical applications such as artificial lungs. We identified a putative β carbonic anhydrase from the tardigrade *Hypsibius exemplaris* (HeCA). Tardigrades are known to survive harsh environments including space, and HeCA could have properties making it well suited for the harsh environments of these biomedical and industrial applications. We report the successful expression, purification, and characterization of HeCA. We utilized a colorimetric and pH-based assay to characterize HeCA's activity as a CA. In the future, we propose to further optimize purification conditions and test the activity of HeCA under more extreme conditions (temperature, acidity, etc.).

(P.10) Monitoring the Endangered Cape Fear Shiner (*Notropis mekistocholas*) Presence in the Cape Fear River Basin Using Environmental DNA
Jack Quintana and Megan Rudock*
Department of Biology, High Point University

Notropis mekistocholas, known as the Cape Fear Shiner (CFS), is an endangered species of minnow fish native to the Cape Fear River Basin. This fish species has been monitored by catch and release, a process that is very time-consuming and not 100% accurate. Instead, environmental DNA can be utilized to identify where CFS are located. Environmental DNA is any genetic information left behind by an organism in its environment. First, species-specific primers were designed using NCBI BLAST to amplify a fragment of the 4F4 microsatellite in the CFS genome, while not amplifying DNA in any other species present. Water samples containing shed DNA of organisms recently in the area were collected and filtered on site. The filter paper is preserved until DNA can be extracted in the lab. DNA was amplified by polymerase chain reaction and PCR products are analyzed using gel electrophoresis. Samples were examined for the presence of DNA using 16S and GAPDH primers, as well as the specified 222bp fragment, indicating the presence of CFS. Preliminary data suggest that our CFS specific primers are successfully amplifying DNA in many of our samples. Sequencing has confirmed the presence of CFS in selected samples, however further analysis is necessary to provide a definitive positive match for CFS and lend confidence to this method of monitoring the endangered Cape Fear Shiner.

(P.11) Demystifying EVs: Increasing Accessibility to a Precious Regenerative Medicine Resource

Elijah Sage[1], David Coltan[1], and Megan Rudock*[,2]
[1]Grekin Laboratories, Warren, MI
[2]Department of Biology, High Point University

Extracellular vesicles (EVs) are small, membrane bound packets of proteins and nucleic acids produced by cells for intracellular communication. Existing research has demonstrated that EVs from a variety of cell types are efficiently taken up by human cells, and as such are an exciting prospect for efficient drug delivery. The literature further shows great promise in using EVs in cell-free therapeutics, as unique EV treatments have been shown to have remarkable tissue-regenerative effects and ameliorate symptoms of several hitherto difficult to treat diseases, including Alzheimer's and Parkinson's. As a result of such potential, EVs for both research and therapeutic purposes are in high demand. Despite the numerous existing EV isolation protocols, including ultracentrifugation, column filtration, and specially designed kits, each option requires either expensive reagents, specialized equipment, or have a low throughput capacity, bottlenecking research and making existing EV-based therapies exorbitantly costly. Our research is therefore focused on testing both existing and novel EV production and isolation techniques to determine their viability for industrial-scale research, and attempting to isolate EVs from unconventional sources, including anaerobic bacteria and plants. In addition, we plan to explore the cellular machinery involved in EV synthesis, attempt to modulate protein expression to promote EV production, and potentially induce specific proteins to be loaded into EVs.

(P.12) Melittin May Induce Multiple Types of Programmed Cell Death in Triple Negative Breast Cancer Cells

Marie Streng, Justus Young, and Y. Kevin Suh*
Department of Biology, High Point University

Programmed cell death (PCD) is also known as regulated cell death and is an essential process in living organisms. Unlike accidental cell death (ACD) which is an uncontrolled cell death and triggered by accidental injury stimuli, PCD occurs under physiological conditions and plays a vital role in homeostasis maintenance. The currently known types of PCD include autophagic cell death, necroptosis, ferroptosis, pyroptosis, and apoptosis, which is also known as "cellular suicide". Triple negative breast cancer is characterized by the lack of estrogen receptor, progesterone receptor, and epidermal growth factor receptor 2 (EGFR2/HER2) expression. Therefore, they are not sensitive to common treatments such as hormone therapy and anti-EGFR2 drugs, and this subtype of breast cancer is considered more aggressive than other types of breast cancer. Melittin is an amphipathic polypeptide with 26 amino acids and a major component of bee venom. Previously, we have shown that melittin inhibits viability and migration of Hs578t triple negative breast cancer cells using MTS assay and Ibidi plates, respectively. In the present study, we investigated the possible mechanism of programmed cell death in melittin treated Hs578t cells using Western blotting, DNA fragmentation, and proluminescent caspase assay.

(P.13) Using COMSOL Multiphysics to Simulate Photodetector Nanowires to Obtain IV Curves, Electric Field, and Carrier Concentration

Levi Wenger, Taylor Cox, Brett Sykes, and Sean Johnson*
Department of Electrical Engineering, High Point University

Nanowires (NWs) are a relatively novel invention that in recent years have been optimized to provide superior performance in photodetectors. Several factors affect the performance of NW photodetectors, including layer arrangements, doping concentrations, material composition, and substrate properties, which are still being investigated today. One of the ways that these factors can be explored is through simulation. However, there has not been much documentation on NW simulation, and the work that has been done has encountered convergence issues for more complex models. In this study, COMSOL's semiconductor module was explored and manipulated to effectively model different types of GaAs and GaAsSb NW structures to obtain data on carrier concentration, electric field, electric potential, and I-V curves.

(P.14) Testing the Neuroprotective Effects of Ashwagandha

Anaiya Whitaker and Michael Grider*
Department of Biology, High Point University

Ashwagandha (*Withania somnifera*), an ancient herb commonly rooted in Asia and Africa, has developed a newfound popularity as a dietary supplement amongst scientists and laypeople. The active ingredient in Ashwagandha, Withaferin A (WFA), has demonstrated a role in reducing inflammation and oxidative stress. Preliminary studies suggest that WFA also has potential as a treatment for traumatic brain injury (TBI). Following TBI, neurons are damaged through oxidative stress. Therefore, we modeled TBI by incubating differentiated SH-SY5Y cells in H2O2 for 24hrs. This generated H2O2-induced oxidative stress, resulting in neuronal dysfunction and cell death. We then tested the therapeutic potential of WFA as a treatment option against the injury. Cells were incubated in a range of concentrations or absent of WFA and cell viability was assessed. Our preliminary data indicates that extremely high doses of WFA make the injury worse. Physiologically relevant concentrations did not further the damage but did not significantly attenuate the injury.

(P.15) Cyclic Voltammetry Investigation of Redox Chemistry of Rhodamine B Amide Derivatives

Darryl Wright and Keir Fogarty*
Department of Chemistry, High Point University

Cyclic Voltammetry (CV) is a technique used to investigate the reduction-oxidation (redox) chemistry of analyte molecules. Our goal is to use cyclic voltammetry to understand redox behavior of our rhodamine B amide derivatives. We have observed in the past that rhodamine B amide derivatives have open and closed forms which exhibit orange and blue fluorescence, respectively. These open and closed forms are associated with different charge states of the molecules, and so they are likely to be redox active. We intend to use CV as a probe to examine whether the forms of the dimer could be controlled. Controlling the dimer would allow us to select which color the rhodamine B amide derivative glows (orange or blue). Our data will tell us the energetics of the color change, potentially allowing for applications in optoelectronics devices.

(P.16) 4-Phenylbutyrate Promotes Mitochondrial Biogenesis and Metabolism in C2C12 Myotubes While Increasing Extracellular BCAA Concentrations During Insulin Resistance

Toheed Zaman[1], Caroline N. Rivera[1], Carly E. Smith[2], Lillian V. Draper[2], Rachel M. Watne[1], Roger A. Vaughan[2], and Andrew J. Wommack*[,1]
[1]Department of Chemistry, High Point University
[2]Department of Exercise Science, High Point University

Branched-chain amino acids (BCAAs) are essential nutrients found in the human diet. Previous studies have established a correlation between elevated levels of BCAAs in the bloodstream and the severity of insulin resistance. Individuals with insulin resistance often exhibit higher concentrations of circulating BCAAs, primarily due to a decrease in the capacity to metabolize BCAAs. 4-Phenylbutyrate (PBA), an ammonia scavenger, has been shown to activate BCAA metabolism, resolve endoplasmic reticulum (ER) stress, and rescue BCAA-mediated insulin resistance. To test this, C2C12 myotubes with or without insulin resistance were treated for up to 24 hours with either 0.5 mM or 10 mM PBA and media contents were then analyzed via an optimized method using liquid chromatography-mass spectrometry (LC-MS/MS). Chromatographic separation and quantification of leucine, isoleucine, and valine was performed using a Shimadzu LCMS-8045 triple quadrupole mass spectrometer. Both doses of PBA increased expression of indicators of mitochondrial biogenesis and PBA treatment also increased extracellular BCAA accumulation during insulin resistance. Taken together, PBA may increase mitochondrial biogenesis, content, and function in a dose-dependent fashion which may have implications for prevention or treatment of metabolic disease such as insulin resistance.

2023 SuRPS Faculty Participation and Projects

Department of Biology

Dr. Mike Grider (Cellular/Molecular Biology)

"Investigation of Cannabinoid-mediated Neuroprotection"

Using cultured neuronal cells, students will establish an oxidative injury, then test the effects of several cannabinoid molecules on cell survival. Four years ago, the US Congress passed the Farm Bill which allowed for the legal cultivation of hemp cannabis and extracts. Since then, psychoactive cannabinoid compounds have entered the commercial market with little or no oversight on the compounds' health effects or toxicity. Recent evidence suggests that CBD, THC, and other cannabinoids can act as strong antioxidants. Here, we will test the in vitro toxicity of cannabis-derived molecules as well as the ability of these compounds to attenuate neuronal injury in an oxidative stress injury model.

Dr. Niky Hughes (Plant Pathology)

"Exploring the Function of Anthocyanins in Red Leaf Spot Infections of Plants"

Plants commonly produce red anthocyanin pigments in leaf spots associated with fungal, bacterial, and viral infections. Yet, despite their common use as diagnostic symptoms of foliar disease, the function of anthocyanins associated with red pathogenic leaf spots is unknown. Many species exhibit chlorosis (yellowing) around sites of infection, which corresponded with an upregulation of genes involved in nutrient uptake during leaf senescence. Perhaps red spots, similarly, merely represent islands of red senescing tissues, just as some species have red autumn leaves while others have yellow. Photoprotection is the most well-supported hypothesis for anthocyanin production during leaf senescence and under nitrogen deficiency, and so this is one possible function of anthocyanins in this context. It is also possible that anthocyanins in red spots contribute directly to the defense response through antimicrobial activity. Anthocyanins are widely recognized for their ability to modulate microbial growth, and have been shown to exhibit potent antimicrobial activity against many human pathogens.

Students working on this project will acquire the following skills: using a fluorometer to quantify photosynthetic stress, using HPLC-MS to determine anthocyanin chemical structure, using microscopy to quantify the effects of anthocyanins on fungal spore germination, and assisting in the isolation of mRNA from various leaf tissues (e.g., red spot, green area around red spot, uninfected green leaf) for comparative analysis.

Dr. Dane Kuppinger (Ecosystem Ecology)

"Investigating the Fire History of the Sauratown Mountains"

The southeastern United States contains isolated sub-xeric forest communities that are dependent upon fire to maintain their structure and species composition. Because fire effects are dependent upon the fire frequency, seasonality, and intensity, knowing the historical fire regime for a location can greatly aid land managers as they design appropriate management plans. Luckily this fire history can be preserved by trees that survive and retain a record of the fire through altered growth rings and charcoal deposited between annual growth rings. Pilot Mountain State Park has one of these fire dependent plant communities and recent work (Kuppinger & Rich 2019) has established the park's fire history back to the mid-1800s. This proposal will build on that work through two lines of research.

The first line of research will add to the fire history of Pilot Mtn by analyzing samples collected in 2022. Among these cross sections are some from stumps left by hand-logging in the early 1900's which should enable the fire history to be extended to the early 1800's. Though some additional field collecting may occur, this project will focus on analyzing collected samples. The second research area will start developing a fire history for Hanging Rock State Park. Some initial samples were collected there during the summer of 2022 but many areas of the park remain un-surveyed and un-sampled. This project will involve identifying, collecting, processing, and analyzing samples.

Dr. Megan Rudock (Genetics)

"Genetic Ecology and Conservation Genetics of Endangered Species in NC"

In collaboration with the North Carolina Wildlife Resource Commission, the Rudock lab aims to develop assays for high throughput monitoring of endangered species. Many aquatic species are monitored by netting, careful identification and counting, which is a labor-intensive practice. Second, the organisms must be plentiful enough to collect and identify. We hypothesize that this surveillance method may be missing organisms that exist in low population areas. We believe that monitoring using environmental DNA may be more successful in identifying the presence of endangered species in areas of low population density. Our SuRPS research project this summer will involve the development and validation of an assay to identify the presence of the endangered Cape Fear Shiner (*Notropis mekistocholas*), a small bony fish found only in the Cape Fear River Basin of North Carolina. We will visit areas of known CFS populations to collect positive control water samples, as well as collect water samples from areas of unknown presence where CFS have not been found since 2007. PCR assays will be developed and validated by DNA sequencing. Another species of interest, the Atlantic Pigtoe Mussel (*Fusconaia masoni*), has a larger distribution range across the southeastern United States which overlaps that of the CFS. Assays can also be developed to identify the presence of the AP mussel, if time permits.

Dr. Kevin Suh (Cellular/Molecular Biology)

"Identifying Novel Cellular Targets of Anti-cancer Compounds in Human Cancer Cells"

Cancer is the second leading cause of death and a major public health issue. In the US, it is known that 1 in 3 women and 1 in 2 men will develop cancer in their lifetime. Prostate cancer is the most commonly diagnosed cancer and second leading cause of cancer-related death in men in the US. In women, breast cancer is very common and triple-negative breast cancer is considered an aggressive subtype of breast cancer as they do not express any of the receptors that are commonly found in breast cancer making them harder to treat. In recent years, we found several compounds that induce cell death in human prostate, cervical, and triple-negative breast cancer cells. These compounds include fisetin, albendazole, and melittin. Fisetin is a plant flavonol found in many vegetables and fruits. Albendazole is an anthelmintic drug used for the treatment of a variety of parasitic worm infestations by targeting microtubules which play an important role in cell division. Melittin is a polypeptide and a major component of honeybee venom. SuRPS projects will involve identifying novel targets of these compounds in cancer cells. The projects would use techniques such as mammalian cell culture, cell viability assay, DNA and protein gel electrophoresis, immunoblot analysis, real time quantitative reverse transcription PCR, RNA sequencing, colony formation assay, immunocytochemistry, and enzyme-linked immunosorbent assay.

Dr. Jeremy Whitson (Geroscience)

"Studying Protein Aging Through the Lens of the Eye"

In order to facilitate vision, the crystalline lens of the eye features unique biological adaptations that generate its transparency. The lens consists primarily of fiber cells which lack all organelles, cannot divide, and cannot produce new proteins. Thus, lens proteins remain in place throughout all of life once synthesized. The lens lays down new fiber cells on top of old cells concentrically throughout life, creating a spatiotemporal gradient of protein ages. By separating the lens into different layers with proteins representative of different ages, the effects of age on various posttranslational modifications can be measured longitudinally just by using lenses obtained at end of life. Using modern proteomic tools, my lab determines how these proteins age and the impact this has on cellular function in order to better understand the process of biological aging.

Department of Chemistry

Dr. Brian Augustine (Materials Science/Nanotechnology)

"Fabrication and characterization of metal-coated polymer nanoporous membranes"

Polymer thin films can be produced with novel micro/nanostructures when they are deposited from solutions under specific deposition conditions. A complicated plate-like structure with large open pores can be created by spin-casting poly methylmethacrylate (PMMA) films from tetrahydrofuran (THF) solutions. The same structure does not form when deposited from other solvents such as chloroform and toluene. These solvents result in much more uniform, smooth films. The microstructure of the THF-deposited films reveal pores on the order of 1 - 10 μm, and the remaining PMMA structures are on the order of 50 - 500 nm. Atomic force microscopy (AFM) has been used to confirm a layered plate-like morphology. The microstructure suggests that nanoporous membranes can be fabricated which can be used in a variety of applications such as filtration, chromatography, battery membranes, catalysis, biosensors or many applications that require a high surface area material. Combining the film structures with electroless Ni, a novel nanostructured polymer could result in not only a high surface area material, but a material that could be metal coated or a metallic nanostructure with a high surface area which are extremely difficult to fabricate using conventional microfabrication technologies. SuRPS students will learn microfabrication, surface characterization using AFM, and metal deposition techniques applicable to biomedical devices.

Dr. Keir Fogarty (Fluorescence Chemistry)

"Characterization of the Optical Properties of Amide Dimers of Rhodamine B"

In this project, we have synthesized the first reported, covalently linked dimers of rhodamine B and fluorescein. By controlling the shape and chemistry of the dye linkers, we have created novel compounds with intriguing applications in sensing. Specifically, our compounds have demonstrated pH, concentration, and humidity sensitivity. In other words, they glow different colors depending on their environment. Such color-changing behavior can be taken advantage of in fields as varied as medical imaging to optoelectronic devices. Students joining my lab can expect to learn such varied techniques as 3D printing, microscopy, fluorometry, and more.

Dr. Kelsey Kean (Biochemistry)

"Exploring Flavoenzyme Structure and Function"

Proteins are among the most abundant and functionally diverse biomolecules with the ability to carry out unique and specific functions and chemistries. In the Kean Lab, we are interested in understanding how proteins evolve and are able to carry out their unique and specific chemistries. A key piece to understanding how proteins work – when working correctly, when behaving aberrantly, or when being engineered for a new function – comes from exploring and understanding protein structure and function on a molecular level. One area of interest in our group is understanding flavoenzymes, a group of proteins that use a special flavin cofactor to carry out a wide range of chemical reactions, using lactate monooxygenase (LMO) and its related family members as model proteins. Student researchers in the Kean Lab will have the opportunity to learn techniques in molecular biology, biochemistry, and structural biology.

Dr. Pamela Lundin (Organic/Polymer Materials)

"Design and Synthesis of Novel Organic Molecules that Address Technological Problems from Solar Cells to Bacterial Infections"

Research in the Lundin Laboratory includes a number of different projects that revolve around three intersecting topics: color, surfaces, and catalysis. At our heart, we are a synthetic laboratory who specialize in the synthesis of novel organic molecules, often by using a Nobel Prize-winning catalysis strategy called cross-coupling chemistry. We have used cross-coupling chemistry to prepare molecules that can more efficiently harvest light in solar cells in a project with a research group at DePaul University and to grow semiconducting polymers from surfaces to prepare patterned films with electronic applications in collaboration with the Augustine Lab. We are interested in how organic structure can alter the color and behavior of dye molecules and collaborate with the Fogarty Lab on this effort. In collaboration with the Blackledge, Fiser, and Brooks Labs, we are developing surface treatments that can inhibit the formation of bacterial biofilms.

Depending on the current state of research in the summer, each SuRPS student in the Lundin Laboratory will work on their own subproject within one of the four projects identified above. These interdisciplinary projects involve the regular use of chemical instrumentation, on which the students will be trained. SuRPS students are encouraged to continue their summer research during the academic year, and most students travel with Dr. Lundin to external conferences to present their results.

Dr. Heather Miller (Biochemistry)

"Genomic and Transcriptomic Approaches to Understanding Antibiotic Potentiation"

The long-term goal of our research is to develop novel anti-virulence treatments to combat persistent and antibiotic resistant bacterial infections. Our overall objectives are to confirm the molecular target of our lead adjuvants in Staphylococcus aureus, investigate this inhibition in clinically relevant strains of methicillin-resistant Staphylococcus aureus, and develop genetic tools to decode mechanistic details of beta-lactam resistance. Our central hypothesis is that our lead compound represents a promising antibiotic adjuvant scaffold that targets the master regulator serine-threonine kinase Stk1. To test this hypothesis, adjuvants will be used as chemical probes to interrogate the Stk1 domain(s) necessary for binding. Comparative transcriptomics will be used to investigate Stk1-mediated gene expression across several strains of MRSA to elucidate differences that could affect development of broadly active inhibitors. Finally, genetic tools will be employed that will systematically mutate phosphorylated substrates to trace Stk1-mediated beta-lactam resistance pathways in these clinically relevant MRSA strains.

Students in the Miller lab will gain expertise in techniques such as RNA purification, real-time PCR, RNA-seq, bioinformatic tools, gene cloning, and CRISPR-Cas9 genome editing.

Dr. Andrew Wommack (Organic/Analytical Chemistry)

"Exploring the Chemical Signals of Plants"

The Wommack Lab will investigate cysteine-rich peptides (CRPs) from plants during the summer of 2023. We will execute the total chemical synthesis of these natural products in collaboration with the Hicks Lab at UNC-Chapel Hill. CRPs are a group of redox-active peptides that mediate many aspects of plant physiology and development. This broad family of peptides has been identified as ligands for membrane receptors to induce plant growth, plant redox defense, plant–bacteria symbiosis, and plant reproduction. Our work will focus on the bacterial interactions of CRPs. The CRPs that we will synthesize will be identified using a blend of in silico antimicrobial peptide (AMP) predictions and peptidomic techniques. Following chemical synthesis, purification of the desired linear peptide will be performed using preparative HPLC. The reduced CRPs will then be oxidatively folded to the disulfide bond form using a GSH/GSSG redox couple in buffer and the progress of this chemical and structural change will be monitored using both analytical HPLC and LC-MS. With putative roles in chemical signaling and host defense, our antimicrobial studies will focus on known Gram-negative plant pathogens, such as in the Xanthomonas and Pseudomonas genera. To better understand the relationship of CRPs with bacteria, quantitative proteomics will be conducted to potentially reveal changes in these bacterial proteomes in response to treatment of sub-lethal concentrations of the synthetic CRPs.

Department of Physics

Dr. Briana Fiser (Engineering Physics)

"Design and Fabrication of Patterned Surfaces to Inhibit Bacterial Biofilm Formation"

The Fiser Lab applies nanoscale techniques to investigate the physics of biological systems, with projects in the fields of polymer physics, fluid dynamics, and biomimetic micro and nanotechnology. Biomimetic technologies allow scientists to both harness the power and creativity of nature and isolate and explore the contributions of individual components within natural processes, like the self-cleaning exhibited by a lotus leaf or the bactericidal capabilities of a cicada wing. The surface of a lotus leaf is blanketed with micron-sized features that contribute to its hydrophobicity, preventing bacterial adherence, and a cicada wing has sub-micron features that penetrate bacterial cell membranes, effectively killing bacteria. Such patterned surfaces show promise as a model for developing new technologies to fight bacterial adhesion and growth on surfaces. Surfaces of interest and impact are those used frequently in the field of human health, such as catheters, IVs, or cardiac stents because they are particularly susceptible to bacterial biofilms. Biofilms cause up to 80% of chronic bacterial infections in humans, and biofilm growth on these indwelling medical devices is particularly difficult to treat due to their presence inside the human body. Additionally, the use of antibiotics has led to increased antibiotic resistance, and the rise in antibiotic resistance is expected to outpace cancer and diabetes combined by 2050. Projects this summer in the Fiser Lab will explore the design and fabrication of patterned nano- and microscale surfaces with applications toward combating the growth of bacterial biofilms on silicone indwelling medical devices.

Department of Electrical Engineering

Dr. Sean Johnson (Semiconductor Materials and Device Characterization)

"Electrical and Optical Characterization in Semiconductors for Photonic Applications"

The next generation of photodetector applications such as photonic integrated circuits (PICs) require photonic components of high speed, high responsivity, high detectivity, high efficiency, low dark current, large bandwidth, flexible and compatibility with high-volume manufacturing associated with Si based CMOS technologies. Other key components within photonic applications include passive devices such as waveguides, couplers, and active devices optical modulators, LEDs and lasers. Research will explore the foundational properties of semiconductors used within these applications, with a focus on semiconductor photodetectors. Characteristics of optical waveguides will be analyzed. Specific detectors to be explored are PN junction, Schottky junction, PIN and Avalanche photodiode configurations. Students will develop models of these devices via Matlab and COMSOL, as well as perform data analysis on III-V nanowire-based photodetectors, which were fabricated in conjunction with the Joint School of Nanoscience and Nanoengineering (JSNN) in Greensboro, NC, and the Shared Materials Instrumentation Facility at Duke University in Durham, NC.

SuRPS 2023 Seminar Series

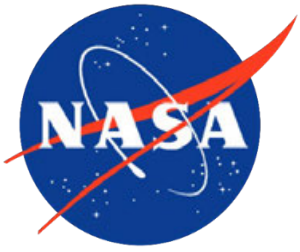
(Friday's @ Noon, Wanek School of Natural Sciences Room 344)

Date	*Name*	*Affiliation*	*Seminar Title*
Friday, June 9	**Prof. Shanthi Iyer** Professor	Joint School of Nanoscience and Nanoengineering, Greensboro, NC	*Nanowire Based Infrared Photodetectors*
Friday, June 15	**Dr. Erin Baker** Associate Professor	Department of Chemistry University of North Carolina, Chapel Hill	*Using Multidimensional Analytical Measurements to Assess Chemical Exposure and Lipodomic Alterations*
Friday, June 23	**Dr. Raluca Gordan** Associate Professor	Department of Biostatistics and Bioinformatics Duke University Durham, NC	*An Unexpected Role for Transcription Factors in DNA Mutagenesis*
Friday, July 7	**Dr. Anthony Dellinger** President and Chief Technical Officer	Kepley Biosystems, Greensboro, NC	*From Ancient Species to Modern Medicine: Harnessing Horseshoe Crab Blood for Early Detection and Antibiotic Susceptibility Testing*
Friday, July 14	**Prof. Kylie Kavanagh** Professor	Wake Forest University School of Medicine Winston-Salem, NC	*Cancelled*
Friday, July 21	**Prof. Mary Ann Lila** Distinguished Professor	Dept. of Food, Bioprocessing and Nutrition Sciences North Carolina State University Raleigh, NC	*Dementia? Disease? Depression? High Anxiety? Relax, There's A Plant for That.*

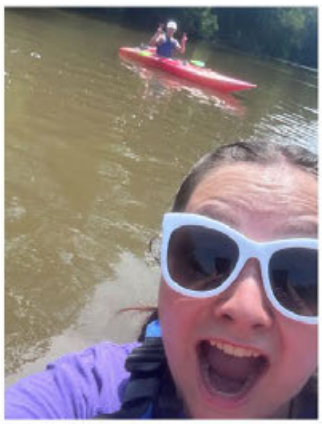
Past SuRPS Keynote Speakers

Year	Speaker	Title
2015	**Rachael Parker, Ph.D.** HPU Chemistry 2011 *Virginia Tech*	*Statistical and combinatorial approaches to designing repeat proteins as recognition elements in microbial sensors*
2016	**Sarah Craven Seaton, Ph.D.** HPU Chemistry/Biology 2004 *UNC Asheville Biology*	*Soirées in the Soil: Bacterial Communication, Cooperation, and Competition in the Rhizosphere*
2017	**Laura Lee, Ph.D.** HPU Biochemistry/Physics 2012 *North Carolina State University*	*Boiling Bugs Break Biomass: An Investigation Into High Temperature, Cellulolytic Microorganisms*
2018	**Gavid Coombs, Ph.D.** HPU Biochemistry 2014 *Yale University*	*A Journey Through Research: Peptide-Catalyzed Atroposelective Coupling of Arenes and Quinones*
2021	**Hailey Parry, Ph.D.** HPU Exercise Science/Chemistry 2017 *National Institutes of Health*	*Key to Success – A Note to Future Graduates*
2022	**Elizabeth Reardon** HPU Biology 2017 *Emmes Company, LLC*	*Planting Seeds: A Perspective on Alternative Paths*
2023	**Calla Telzrow, Ph.D.** HPU Biology 2016 *RFI at PPD*	*Underappreciated & Underestimated: Implications of Human Fungal Pathogens and Genetic Approaches to Understanding Them*

SuRPS 2023 Was Partially Supported By The Following Organizations:

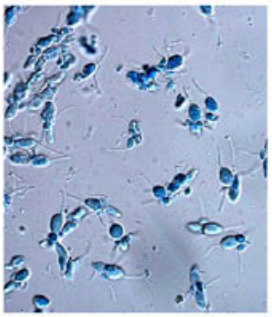


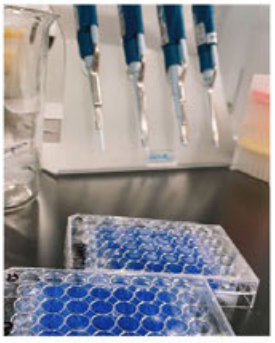
Even More Scenes from SuRPS…

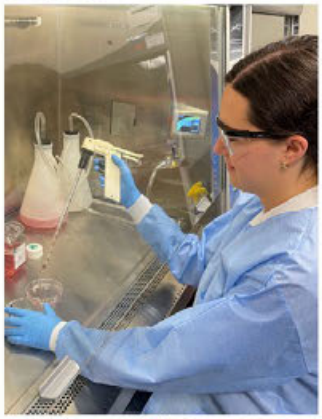
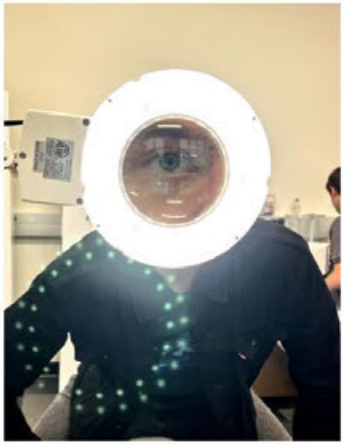
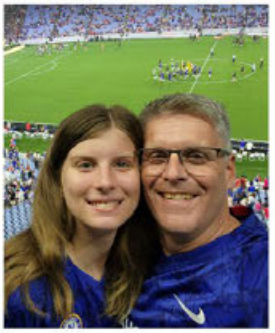



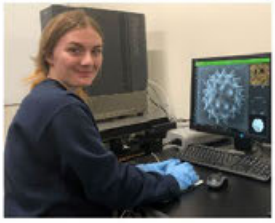


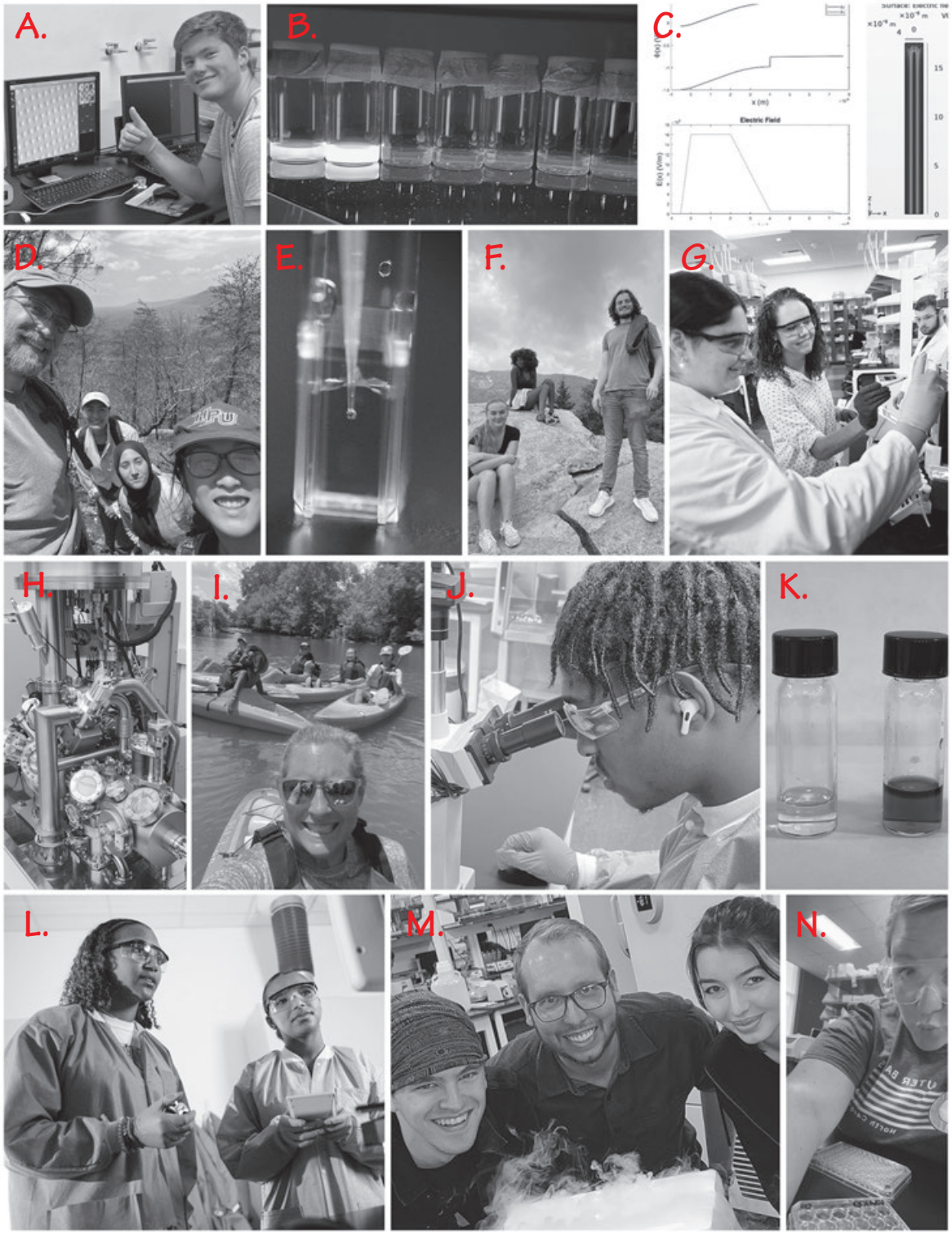








(A.) Electron microscopy of 10 μm structures in the Fiser Lab; (B.) Fluorescent dimer samples in the Fogarty Lab; (C.) COMSOL modeling of core-shell nanowires in the Johnson Lab; (D.) Surveying and sampling at Hanging Rock State Park in the Kuppinger Lab; (E.) Spectroscopy of expressed proteins in the Kean Lab; (F.) Field sampling of anthrocyanin-rich leaves in the Hughes Lab; (G.) Methicillin-resistant Staphylococcus aureus (MRSA) analysis in the Miller Lab; (H.) X-ray photoelectron spectroscoy (XPS) in the Augustine Lab; (I.) Fish sampling and paddling with the Rudock Lab; (J.) Microscopy of cancer cells in the Suh Lab; (K.) Chromatography fractionation of anthrocyanin samples from the Wommack Lab; (L.) Sample preparation in the cell culture lab in the Grider Lab; (M.) Eye aging studies in the Whitson Lab; (N.) 96 well plate preparation in the Lundin Lab