2021

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

Wanek School of Natural Sciences

Thursday, July 29 & Friday, July 30

Hits From The SuRPS 2021 Playlist...

2021 SuRPS KEYNOTE SPEAKER

"*Key to Success – A Note to Future Graduates*"

Hailey Parry, Ph.D.

(HPU Exercise Science/Chemistry Class of 2017)

Post-Doctoral Researcher

National Heart, Lung and Blood Institute

National Institutes of Health, Bethesda, Md

ABSTRACT

Research is 85% trouble shooting and 15% research. My talk will discuss my successful, unsuccessful, and most important learning moments throughout my graduate study. I will discuss both publishable and unpublishable projects that were performed over the past four years. Furthermore, I will discuss the reality that mistakes are made throughout graduate school, and how they should be used as learning opportunities rather than depression points throughout the learning process. The last part of my talk will cover the key points that I found most helpful throughout my graduate studies. The most important of these which I will highlight is the importance of picking a kind, supportive mentor. I hope to provide important tips to evaluate whether an individual is an appropriate mentor, and other key strategies and support systems which were most useful when finishing my PhD.

BIO

Hailey Parry received her B.S Degree in Exercise Science and B.A. Degree in Chemistry from High Point University in 2017. During her tenure at HPU, she participated in the SuRI program in 2016 working in the exercise physiology laboratory with Dr. Kyle Sunderland and in the biomechanics laboratory with Dr. Kevin Ford. In August 2017, she began her graduate studies in Kinesiology at Auburn University under the direction of Prof. Andreas Kavazia studying mitochondrial function and oxidative stress using exercise, lactation, and migration as a skeletal muscle stressor. She completed her MS in 2018 and her PhD in May 2021. She began a post-doctoral fellowship at the National Heart, Lung and Blood Institute (NHLBI) at the National Institutes of Health (NIH) in Bethesda, MD in June 2021. Her current research project is on developing methods to look at mitochondrial structure and function simultaneously and mitochondrial structure in diabetic individuals.

SuRPS Final Symposium

(Thursday, July 29, 2021, Culp Planetarium, Wanek School of Natural Sciences)

Session I: Oral Presentations: Dr. Keir Fogarty, Department of Chemistry, Presiding

	8:30 – 9:00		*COFFEE, TEA RECEPTION (WSNS Lobby)*
	9:00 - 9:05	Dr. Brian Augustine	Opening Remarks and Announcements
	9:05 – 9:20		Poster Session Part A Elevator Pitch
Th.1	9:20 - 9:40	Brianna Viering Ashely King	*Evaluation of Small Molecule Adjuvants and their Effect on Resistance Genes in Methicillin Resistant Staphylococcus aureus (MRSA)*
Th.2	9:40 – 10:00	Ashleigh Purvis Zoe Brown	*Synthesis of Cysteine Rich Plant Peptides Involved in Host Defense*
Th.3	10:00 - 10:15	Sadie Flagg	*Examining the Impact of BHT Inhibitor on the Microstructure of Spun-Cast Nanoporous Films of PMMA Exhibiting High Surface Areas*
Th.4	10:15 - 10:30	Isabelle Parker	*Confirming a New Method for Identifying Variable Hot Subdwarf Stars with NASA's TESS Spacecraft*
Th.5	10:30 - 10:45	Rachel Day	*Synthesis of a Focused Library of Loratadine Analogs and Evaluation of Their Antibiotic Adjuvant Activity in MRSA*
	10:45 – 11:00		*BREAK*

Session II: Keynote Address: (Introduction by Dr. Meghan Blackledge, Department of Chemistry)

11:00 - 12:00	**Hailey Parry, Ph.D.** (HPU Class of 2017) National Institutes of Health	**Keys to Success – A Note to Future Graduates**
12:00 - 1:30		*LUNCH BREAK*

SuRPS Final Symposium

(Thursday, July 29, 2021, Wanek School of Natural Sciences)

Session III: Poster Presentations Part A 1:30 – 2:30 p.m.

Posters will be set up in the hall and lobby of the Wanek School of Natural Sciences. All posters should be set up by 1 pm on Thursday for both poster sessions.

2:30 - 2:40		*BREAK*

Session IV: Oral Presentations: Dr. Jarrett Lancaster, Department of Physics, Presiding

Th.6	2:40 - 3:00	Hannah Smith Brenna Ivory	*Mutation of Y31 and R44 in Putative Mannose-6-Phosphate Domain Leads to Atg27p Mislocalization*
Th.7	3:00 - 3:15	Evan Silver	*Effects of Self-assembled Monolayer Structure on Conjugated Polymer Morphology*
Th.8	3:15 - 3:35	Brandy-Fey Stratton Anna Wohlwend	*Analyzing Spectral Data of Rhodamine B Dimer and Related Compounds*
Th.9	3:35 - 4:00	Maggie Salley Anna Ferraro Bailey McCormick	*Characterizing Biochemical Responses Originating From Leaf Pathogenic Stress: A Spotlight on Red Spots*
Th.10	4:00 – 4:15	Luke Schooley	*Toward Noninvasive Assessment of Action Potential Stability Using Neural Learning*
Th.11	4:15 – 4:30	Kennedy Robinson	*Variation in Woodchuck Feeding Behavior Between Purple and Green Cabbage*
Th.12	4:30 – 4:45	Julia Velasquez	*Determination of a Regenerative Response via Cholinergic Activation in Zebrafish*

SuRPS Final Symposium

(Friday, July 30, 2021, Culp Planetarium, Wanek School of Natural Sciences)

Session V: Oral Presentations: Dr. Kristin Ackerman, Department of Biology

	8:30 – 9:00		*COFFEE, TEA RECEPTION (WSNS Lobby)*
	9:00 - 9:20		Poster Session Part B Elevator Pitch
Fr.1	9:20 - 9:40	Caden Sanchez Jack Munn	*An O-C Analysis of Hot Subdwarf + Red Dwarf Binaries Observed by NASA's TESS Spacecraft*
Fr.2	9:40 – 10:00	Kate Taylor Alec Garfield	*The Effect of Direct vs. Diffuse Light on Photosynthetic Rates and Water-Use Efficiency*
Fr.3	10:00 - 10:15	Ryan Hesterman	*Validation and Characterization of Zebrafish as a Model for Fetal Alcohol Spectrum Disorders*
Fr.4	10:15 - 10:30	Scott Colton	*Investigating Spiral Wave Dynamics in Cardiac Tissue Using Reaction Diffusion Models*
Fr.5	10:30 – 10:45	Luke Akers	*Identification of Economical Cross-Coupling Catalysts by Small Scale Reaction Screening with Gas Chromatography-Mass Spectrometry*
Fr.6	10:45 – 11:05	Sophie Gregory Jessica Emrich	*Synthesizing Derivatives of 4-bromo-9H-carbazole in the Development of Antibiotic Adjuvants to Target Antibiotic Resistance*
	11:05 - 11:15		*BREAK*

Session VI: Poster Presentations Part B 11:15 – 12:15 p.m.

Posters will be set up in the hall and lobby of the Wanek School of Natural Sciences. All posters should be set up by 1 pm on Thursday for both poster sessions.

Lunch at Farmer's Market

Special Thanks:

Dr. Joanne Altman, Director HPU Undergraduate Research and Creative Works Program
Dr. Brett Woods, Interim Dean, Wanek School of Natural Sciences
Rebecca Smoak, Biology, Chemistry and Physics Administrative Assistant extraordinare
Becky Poore, WSNS Administrative Assistant
Wanek School of Natural Sciences and High Point University for financially supporting the SuRPS 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, Allison Lightner, HPU Office of Communications
Alec Garfield ('22 Biology), Inside program cover design

STUDENT ABSTRACTS ORAL PRESENTATIONS:

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

(Fr.5) Identification of Economical Cross-Coupling Catalysts by Small Scale Reaction Screening with Gas Chromatography-Mass Spectrometry

Luke Akers[1], Rory King[1], Angelina Pierre[1], Scott Geyer[2], Xiao Ma[2], Megan Page[2], Connor Taggart[2], and Pamela Lundin[*,1]
[1]Department of Chemistry, High Point University
[2]Department of Chemistry, Wake Forest University, Winston-Salem, NC

Palladium on carbon nanoparticles (Pd/C) have long been used as an effective heterogeneous catalyst for cross-coupling reactions, such as the Suzuki reaction and Buchwald-Hartwig reaction. Heterogenous catalysts are attractive options for industrial-scale reactions as the expensive catalyst can be easily removed from the reaction and reused. However, Pd nanoparticles have been shown to leach palladium atoms off of the carbon nanocrystal surface. Once dissociated in solution it becomes more difficult to remove the palladium upon completion of the reaction, leading to product contamination. The leaching also limits the reuse of the catalyst, ultimately resulting in higher costs and a more deleterious environmental impact. We sought to find a more affordable and environmentally friendly replacement for the classic palladium nanoparticle catalyst by alloying the palladium with nonmetals, in particular palladium phosphide on carbon (PdPx/C) and palladium boride on carbon (PdBx/C). The alloying of palladium with phosphorous and boron alters the electronic properties of the palladium and may prevent palladium leaching. We will present our results using small-scale screening and analysis via gas-chromatography-mass spectrometry (GC-MS) to compare these two catalysts to commercially purchased palladium on carbon in the Suzuki reaction. Additionally, we have looked at eliminating the need for palladium entirely by employing cobalt phosphide (CoP), copper (Cu), and copper nitride (Cu3N) nanocrystal catalysts, which were tested in cross-coupling reactions with positive preliminary results.

(Fr.4) Investigating Spiral Wave Dynamics in Cardiac Tissue Using Reaction Diffusion Models

Scott Colton and Jarrett Lancaster*
Department of Physics, High Point University

We employ the Fitzhugh-Nagumo (FHN) reaction diffusion model of an action potential to study the excitation, destruction, and propagation of spiral waves—a type of localized action potential pattern that interferes with normal signal propagation. Using MATLAB, we investigated several methods for creating and sustaining spiral wave patterns in the two-dimensional FHN model. Results are presented depicting the dynamics that occur in the presence of spatially-varying diffusion and barriers in order to simulate the effects of diseased tissue. The difficulty in initiating a breakup of the spiral wave and its relevance to atrial and ventricular fibrillation is also discussed.

(Th.5/P.3) Synthesis of a Focused Library of Loratadine Analogs and Evaluation of Their Antibiotic Adjuvant Activity in MRSA

Rachel Day, Nicholas Kirby, Ashley King, Rebecca Ulrich and Meghan Blackledge*
Department of Chemistry, High Point University

Methicillin-resistant Staphylococcus aureus (MRSA) killed approximately 20,000 people in 2017. Antibiotic resistant bacteria, such as MRSA, are more difficult to treat and thus, more lethal than antibiotic susceptible strains. One way to combat this is utilizing adjuvants in combination with antibiotics. Adjuvants block resistance mechanisms in the bacteria, allowing an antibiotic to regain its activity. Based on previous work in our lab, we identified loratadine, the active ingredient in Claritin, to be effective as an effective adjuvant against MRSA. We further determined that the carboxy-ethyl tail of loratadine is essential for adjuvant activity. While the carboxy-ethyl tail is required for adjuvant activity in the bacteria, this tail is easily cleaved by the liver in the human body, obliterating adjuvant activity. Because of this, we want to design a more potent and long-lasting adjuvant with tails that won't be cleaved by the body. The goals of this project are two-fold: first, understanding the molecular limitations of size, shape, and composition for generating activity, and second, creating analogs that would be more potent for adjuvant activity. We have synthesized a focused library of loratadine analogs and have identified several that have antibiotic adjuvant activity. Synthetic details, a putative structure-activity relationship, and preliminary biological results will be presented.

(Th.3) Examining the Impact of BHT Inhibitor on the Microstructure of Spun-Cast Nanoporous Films of PMMA Exhibiting High Surface Areas

Sadie Flagg, Todd Knippenberg, Sarah Colbert, Sarah Juidice and Brian Augustine*
Department of Chemistry, High Point University

Tetrahydrofuran (THF), a common organic solvent for polymers, is often stabilized with butylated hydroxytoluene (BHT) due to THF forming peroxide compounds. In prior work we have shown that solutions of 996 kg/mol poly(methyl methacrylate) (PMMA) dissolved at a concentration of 15.0 mg/mL in THF and spun-cast onto Si substrates produces thin nanoporous films unlike smooth films prepared from other solvents such as toluene and chloroform. In this study, we examined the effect of the interaction between BHT and THF on the PMMA films by varying the concentration of BHT present in the THF solutions from 0 - 5000 ppm. The influence of BHTs molecular structure was then examined by replacing the BHT with analogous compounds phenol and p-cresol in THF. Solutions also prepared with toluene and BHT were tested to determine if the films produced using BHT alone caused microstructural changes. Optical microscopy of the films exhibits color variation which may be due to opalescence caused by porosity variations in the films. All films were examined using tapping mode Atomic Force Microscope (AFM) imaging. While the toluene/BHT and the THF/phenol solutions produced smooth films the p-cresol solution exhibited some areas of porous structure similar to the THF/BHT solutions. This suggests the importance of both the butyl and methyl groups in BHT in order to produce the nanoporous structure formation of PMMA. Varying concentrations of BHT appears to have a direct effect on the porosity of the films, although this may be dependent on the presence of water in the THF, as new anhydrous THF reproduced these results with less reliability. We are in the process of performing molecular dynamic (MD) simulations on the solvent and inhibitor solutions to better determine the origin of the nanoporous film structure and thus understand the molecular interactions resulting in the film morphology.

(Fr.2) The Effect of Direct vs. Diffuse Light on Photosynthetic Rates and Water-Use Efficiency

Alec Garfield[1], Kate Taylor[1], Mechelle Jiang[2], Gregory Goldsmith[3], and Carter Berry[*,1]
[1]Department of Biology, High Point University
[2]Department of Biology, Wake Forest University, Winston-Salem, NC
[3]Schmid College of Science and Technology, Chapman University, Orange, CA

While plants cannot survive without sunlight, not all light is the same; both light quantity and spectral quality affect photosynthesis. However, one other key variable of light, direct or diffuse, is largely overlooked. New research demonstrates that diffuse light can double photosynthesis while maintaining similar rates of water-use, yet the mechanism driving this observation remains unresolved and has major implications for optimizing crop productivity and managing ecosystems. The goal of this project was to develop a mechanistic understanding of how light quality, leaf structure, and biochemistry interact to affect tomato plant productivity. We compared the effect of sustained and short-term exposure to diffuse light on rates of photosynthesis and water-use efficiency, identified potential leaf traits that may affect photosynthetic response to diffuse light, and quantified the effects of sustained exposure to direct vs. diffuse light on plant growth and morphology. Across 9 cultivars, we found noticeable variation in plant function in response to light environment. This was somewhat explained by clear changes to stomatal conductance in response to diffuse light. To date, we also find that leaf biochemical efficiency is not dramatically altered in diffuse light. The results from this study demonstrate a strategy for plants to enhance their ability to fix carbon without dramatic effects on their ability to maintain water. Uncovering this mechanism will lead to new research agendas that inform trait breeding initiatives and optimize greenhouse infrastructure. Finally, as climate change creates a hotter and drier world, this work opens new avenues to explore plant productivity.

(Fr.6) Synthesizing Derivatives of 4-bromo-9H-carbazole in the Development of Antibiotic Adjuvants to Target Antibiotic Resistance

Sophia Gregory, Jessica Emrich, Ashley King and Meghan Blackledge*
Department of Chemistry, High Point University

Antibiotic resistance is growing at an alarming rate and current antibiotics are no longer effective treatments against resistant strains of bacteria. To address this, antibiotic adjuvants are being synthesized to target antibiotic-resistance mechanisms, which potentiates our arsenal of antibiotics. Our lab has identified 4-bromo-9H-carbazole as an antibiotic adjuvant in MRSA, potentiating the activity of several ß-lactams. However, continued research on synthesizing novel carbazoles is required because of the lack of commercially available derivatives and difficulty synthesizing and modifying the scaffold. Our goal is to find the best way to synthesize the scaffold and further derivatize it to improve antibiotic adjuvant potency and increase our library of analogs for biological testing. The first reaction we are utilizing is the photo-redox catalyzed Cham-Lam coupling reaction. This forms a decorated diphenylamine, which can then be cyclized under acidic conditions to form the desired carbazole. This method has afforded a number of novel carbazole derivatives with various substitution patterns and functional groups. N-alkylation of our lead carbazole is being utilized in further derivatization of the molecule. We have attached an epoxide with a short linker to the carbazole nitrogen. Epoxide opening with a variety of nucleophiles afforded products featuring an alcohol, to improve solubility and bioavailability, and other functional groups to improve target binding and facilitate a structure-activity relationship study at this location. Synthetic methodologies and preliminary biological data will be discussed.

(Fr.3) Validation and Characterization of Zebrafish as a Model for Fetal Alcohol Spectrum Disorders

Ryan Hesterman, and Kristin Ackerman*
Department of Biology, High Point University

Fetal alcohol spectrum disorder (FASD) is a term that describes a number of conditions associated with exposure to ethanol (Eth) during embryonic development, including physical malformations and cognitive deficits. Each year, FASDs affect nearly 1 in 100 children born in the United States. Ethanol functions through binding to gamma-aminobutyric acid (GABA) receptors, which typically binds GABA, a major inhibitory neurotransmitter of the nervous system. Zebrafish (Danio rerio) is a growing model for understanding development primarily because of their semi-transparent embryos allowing for careful observations throughout development, ability to be pharmacologically manipulated beginning at the 1-cell stage, and rapid reproduction. Therefore, zebrafish are a valuable model for understanding the effects of ethanol exposure on embryonic development. The severity of FASDs is highly dependent on the concentration of ethanol, the duration of ethanol exposure, and the gestational phase of ethanol exposure. Previous studies using zebrafish have supported that exposure to ethanol prior to or during gastrulation (6 hours post fertilization (hpf)) results primarily in physical abnormalities, where exposure to ethanol later in development (24 hpf) results mainly in cognitive deficits displayed in FASDs. Thus, the current goal in our lab is to identify the specific developmental stage in which ethanol induces a less severe cognitive defect in contrast to a more severe anatomical etiology. This study aims to investigate the timing of cognitive defects through the use of a Novel Tank Test and an Inhibitory Avoidance Test, two established assays that rely on intact motor and visual functions.

(Th.6/P.7) Mutation of Y31 and R44 in Putative Mannose-6-Phosphate Domain Leads to Atg27p Mislocalization

Brenna Ivory, Hannah Smith and Veronica Segarra*
Department of Biology, High Point University

While mutations of the C-terminus of Atg27, a transmembrane protein that contributes to cellular self-eating or autophagy, are known to control the localization of the protein throughout the endosomal/vacuolar system, the effects of abrogating its predicted mannose-6-phosphate receptor domain (MRH) remain unknown. We have discovered that mutation of the putative Atg27 MRH most likely leads to its mislocalization to the ER.

(Th.1) Evaluation of Small Molecule Adjuvants and their Effect on Resistance Genes in Methicillin Resistant *Staphylococcus aureus* (MRSA)

Ashley King, Brianna Viering, Taylor Cunningham, Lauren Kaelin, Dexter Boldog, Rachel Bernsden, Heather Miller* and Meghan Blackledge*
Department of Chemistry, High Point University

Staphylococcus aureus is a gram-positive pathogen that causes systemic and soft tissue infections in humans and livestock. *S. aureus* is the main cause of infections in both healthcare and community settings. Unfortunately, *S. aureus* has become resistant to multiple antibiotics such as β-lactams and cephalosporins therefore limiting treatment options. We are focused on exploring possible antibiotic adjuvants to effectively restore antibiotic sensitivity by targeting the PASTA kinase, serine threonine kinase 1 (Stk1), which is known to regulate genes involved in β-lactam resistance. We have screened a library of carbazoles and identified several active compounds that have helped us elucidate a structure activity relationship. Through this screening process three lead compounds were identified with 4-bromocarbazole being the most effective at β-lactam potentiation. Next we investigated how these novel adjuvants affected MRSA on the molecular level. We hypothesized that upon treatment with the antibiotic oxacillin and our adjuvant the expression levels of key resistance genes would decrease in comparison to the levels found when treated only with oxacillin. This was evaluated by conducting RT-qPCR and comparing the results of four treatment types to determine the effect of the adjuvant. In our results we have found that *blaZ* and *mecA* are both upregulated with oxacillin treatment, but downregulated when our lead carbazole is included. We also found that the trends the genes follow vary between different strains of MRSA. Together, these results describe a novel Stk1 inhibitor that leads to β-lactam potentiation through the downregulation of genes in the *bla* and *mec* operons.

(Fr.1) An O-C Analysis of Hot Subdwarf + Red Dwarf Binaries Observed by NASA's TESS Spacecraft

Jack Munn, Caden Sanchez, and Brad Barlow*
Department of Physics, High Point University

Hot subdwarf stars represent stellar evolution interrupted; they form when a red giant star is stripped of its outermost layer by a nearby orbiting companion. Most are found in fast binary orbits with periods typically between two and twelve hours and have either white dwarf or red dwarf companions. Their properties help shed light on various phenomena in stellar astrophysics and even cosmology. In particular, monitoring the orbits of hot subdwarfs with red dwarf companions can help us constrain binary evolution rates and understand the survivability rates of planets during their host stars' red giant phase. Observed minus calculated (O-C) studies allow one to measure miniscule variations in the orbital periods of these systems by comparing observed eclipse timings to a calculated ephemeris. This technique is useful for detecting period changes due to secular evolution of the binary, gravitational wave emission, or even reflex motion from an orbiting circumbinary object. Here we present updated O-C diagrams for several hot subdwarf + red dwarfs binaries using data obtained with NASA's TESS spacecraft. For all systems, we measure the most precise orbital periods ever determined for these systems — in some cases to a precision of milliseconds. We also report on a handful of systems whose timings deviate from our predicted ephemeris and provide interpretations for such deviations.

(Th.4) Confirming a New Method for Identifying Variable Hot Subdwarf Stars with NASA's TESS Spacecraft

Isabelle Parker[1], Will Frondorf[1], Kyle Corcoran[2], J.J. Hermes[3] and Brad Barlow[*,1]
[1]Department of Physics, High Point University
[2]Department of Astronomy, University of Virginia, Charlottesville, VA
[3]Department of Astronomy, Boston University, Boston, MA

Hot subdwarf stars are stripped red giant stars that can vary in brightness over time due to pulsations, eclipses, the reflection effect, and ellipsoidal modulation. Detailed studies of their light curves can allow us to better understand this enigmatic stage in the life cycle of stars, as well as help solve stellar parameters through asteroseismological analysis and binary light curve modeling. Additionally, they can reveal orbiting exoplanets as well as Type Ia supernova progenitors. From an analysis of brightness errors generated from the European Space Agency's Gaia spacecraft, we have identified nearly 800 candidate hot subdwarf stars with inflated brightness errors for their magnitudes, a strong indicator of photometric variability. We obtained follow-up light curves from NASA's TESS space satellite for 191 systems. This has allowed us to both uncover new variable star systems as well as collect high signal-to-noise light curves of previously known systems. More than 90% of our targets show significant changes in brightness. Thus, Gaia flux errors serve as a powerful tool in identifying variable candidates. While the majority of observed systems were cataclysmic variables, we report the discovery of many new variable hot subdwarf systems, including HW Vir binaries, reflection effect systems, pulsating stars, ellipsoidally modulated systems, and several other systems of unknown classification. This study illustrates the usefulness of Gaia brightness errors in finding variable star systems.

(Th.2) Synthesis of Cysteine Rich Plant Peptides Involved in Host Defense

Ashleigh Purvis[1], Zoe Brown[1], Leslie Hicks[2], and Andrew Wommack[*,1]
[1]Department of Chemistry, High Point University
[2]Department of Chemistry, University of North Carolina at Chapel Hill, Chapel Hill, NC

A family of antimicrobial peptides (AMP) in plants, known as plant defensins, play important roles in the innate immune response to potentially infectious pathogens. Defensins commonly contain a number of highly conserved cysteine residues that can be found in a reduced free-thiol form or involved in sulfur-to-sulfur disulfide bonding. The biological roles of defensins in innate immunity, mechanisms of action, structural dynamics, and therapeutic potential continue to be interesting research topics. Cysmotif Searcher, an in silico AMP prediction tool, was used to identify two novel defensin-like peptides in the ghost pepper plant (Capsicum chinense), CC-AMP1 and CC-AMP2. The peptides CC-AMP1 and CC-AMP2 contain 32 and 37 amino acids, respectively, and have six cysteine residues that adopt a 1–6, 2–5, 3–4 disulfide bonding pattern upon oxidation, as confirmed by proteolytic digestion and MS/MS analysis. Synthetic production of these structures was enabled by using semi-automated solid-phase peptide synthesis (SPPS) to make two fragments, which were then linked together by performing a native chemical ligation reaction. Synthetic access to natural products, such as CC-AMP1 and CC-AMP2, can enable more detailed characterization of their multifaceted roles in signaling and host defense.

(Th.11) Variation in Woodchuck Feeding Behavior Between Purple and Green Cabbage

Kennedy Robinson, Brett Woods* and Christian George*
Department of Biology, High Point University

There have been many tests done on plant color preference with herbivore insects on red and green leafs. Some articles found that they preferred green over red and some found the opposite. But there have been few tests done on plant color preference with herbivore mammals. Color preference for insects and animals against red and green plants is hard to determine because of the potential of other factors playing a role on why they chose one over the other; for example smell and site differences. In this experiment we aimed to answer the question, do woodchucks/ marmots have a color preference on purple vs green leaves? It was hypothesized that woodchucks/marmots would choose green leaves over red/purple because of anthocyanins being present in red/purple leaves; which are used as a defense mechanism for the plant to protect them against sunlight and herbivore animals to tell them not to eat the plant. While green signals to the animal that it is rich in nutrients. The experiment was done by setting up hunting cameras in 4 different areas and performing a choice test with purple and green cabbage. The results showed that green cabbage was chosen the majority of time and was eaten at a faster rate by the woodchuck. Purple cabbage was eaten but was not the animals first choice and was eaten at a slower rate. This shows that the woodchuck does have a preference over purple or green cabbage but it does not answer the question of why and if there are other factors playing a role in their decision.

(Th.9/P.12) Characterizing Biochemical Responses Originating From Leaf Pathogenic stress: A Spotlight on Red Spots

Maggie Salley[1], Bailey McCormick[1], Anna Ferraro[1], Andrew Wommack[2] and Nicole Hughes[*,1]
[1]Department of Biology, High Point University
[2]Department of Chemistry, High Point University

Red leaf spots commonly accompany pathogen infection in plants. Yet, the function of red anthocyanins in infected tissues is unknown. We characterized biochemical responses of two plant species, Red-tip Photinia (*Photinia glabra*) and Indian Hawthorn (*Rhaphiolepis indica*), infected by the pathogenic fungus, *Entomosporium mespili*. We used analytical HPLC and LC-MS to identify and quantify anthocyanins, photoprotective carotenoids (lutein, xanthophyll cycle pigments), and chlorophyll data in red tissues (red expanding, red senescing, red spots) and green tissues (green areas around red spots, fully-expanded green leaves) from the same plants. Maximum quantum yield efficiency of PSII (F_v/F_m) was measured as a proxy for sustained photo-oxidative 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 Photinia also contained small amounts of three additional cyanidin mono-glycosides (cyanidin-3-*O*-glucoside and two un-identified cyanidin-*O*-pentosides); red spots lacked cyanidin-3-*O*-arabinoside. All red tissues had significantly lower chlorophyll and F_v/F_m 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 is likely photoprotection (i.e. light attenuation and antioxidant defense).

(Th.10) Toward Noninvasive Assessment of Action Potential Stability Using Neural Learning

Luke Schooley and Jarrett Lancaster*
Department of Physics, High Point University

In this project, the link between stability of nonlinear wave propagation and cardiac health is explored. We present results obtained from applying machine learning to the problem of assessing cardiac fitness by using only data which can be collected noninvasively. In a world of endless data, machine learning algorithms find underlying trends in large sets of data. We use the two-variable Fitzhugh-Nagumo (FHN) equations, to model electrocardiogram (EKG) signals using MATLAB. A neural network is presented which we developed to obtain a map between noninvasively measured EKG metrics and model parameters. With this mapping, we discuss how real-time stability analysis can be performed to provide meaningful biofeedback.

(Th.7) Effects of Self-assembled Monolayer Structure on Conjugated Polymer Morphology

Evan Silver and Pamela Lundin*
Department of Chemistry, High Point University

Self-assembled monolayers (SAMs) are molecular assemblies that spontaneously adhere to surfaces by head groups and can be functionalized at the tail end to modify the properties of that surface. For example, SAM structures can be manipulated to alter the conductivity of the surface or lead to antimicrobial activity. In this work, we are using SAMs for surface-initiated polymerization (SIP) of conjugated polymers to form conjugated polymer brush (CPB) films. In particular, we are investigating the impact of the SAM structure on the polymer growth and resulting film morphology of CPB films of polythiophene (PT) and poly(3-hexylthiophene) (P3HT) on silicon wafers, glass, and gold/chromium-plated surfaces. We will present our methodology for synthesis of functionalized SAMs, polymerization, and characterization of the resulting CPB films by atomic force microscopy (AFM) and water contact angle measurements.

(Th.8) Analyzing Spectral Data of Rhodamine B Dimer and Related Compounds

Brandy-Fey Stratton, Anna Wohlwend, Charles Edwards, Elizabeth Riser, Angelina Pierre, Pamela Lundin* and Keir Fogarty*
Department of Chemistry, High Point University

Within recent years, there has been an increase in studies related to rhodamine spriolactams due to their potential photoswitching capabilities which can be used in a variety of fields, for example the creation of 3D light displays. Throughout the project, our group has been working with Dr. Lundin's organic chemistry lab who have synthesized a rhodamine B dimer that has two photoswitching spirolactam groups. When exposed to UV light, this Rhodamine B dimer has shown the ability to emit two different wavelengths of light--- orange and blue--- which is hypothesized to be the result of the molecule's different conformational states which we have been investigating using fluorometry. The excitation and emission wavelengths of this dimer and other control compounds that are similar to the dimer have been measured in a variety of solvents in an attempt to figure out what specifically about this compound is resulting in these behaviors. The solutions made in our lab were generated specifically to observe how the compound interacts in solvents with a range of hydrophobicity and pH values. It is the hope of our lab that understanding the conditions needed to form the specific blue or orange conformers will be a useful addition to the photoswitching industry.

(Th.12) Determination of a Regenerative Response via Cholinergic Activation in Zebrafish

Julia Velasquez, Marlo Hemerson, Jeremy Muhr, Lauren Pfermenges, Sarah Juidice, Annie Rexha, and Kristin Ackerman*
Department of Biology**,** High Point University

The number of Americans diagnosed with retinal degenerative diseases such as age-related macular degeneration (AMD) and glaucoma, which lead to irreparable damage and permanent vision loss, are expected to double in the next 30 years. Due to the inability of human/mammalian retinal tissue to regenerate, there is no known cure or treatment therapy able to reverse this damage. To provide insight regarding the development of retinal degeneration therapies, biomedical researchers are focused on non-mammalian animal models to investigate potential mechanisms by which photoreceptor regeneration occurs. In contrast to the mammalian system, zebrafish (*Danio rerio*) maintain an innate and robust ability to regenerate all damaged retinal cell types by means of Müller glia, or retinal stem cells capable of generating multipotent retinal progenitor cells that migrate to the damaged retinal layer(s) and replace the neuronal cell type(s) that were lost/damaged. Recent studies with Long Evans rats determined that after eye drop treatment with PNU-282987, an α7 nicotinic acetylcholine receptor agonist, retinal neurons were generated without the presence of a retinal injury or growth factors. To determine if cholinergic activation in the adult zebrafish could also mount a regenerative response, zebrafish were interperitoneally-injected with 10 μM nicotine, eyes were enucleated, and retinal sections were processed via immunohistochemistry for activated Müller glia (the hallmark mechanism for the regenerating retina).

STUDENT ABSTRACTS POSTER PRESENTATIONS:

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

(P.1) Potentiating Antibiotics to Target Multidrug Resistant ESKAPE Pathogens

Brooke Allen and Meghan Blackledge*
Department of Chemistry, High Point University

In an article published in the *Infectious Disease Society of America*, ESKAPE pathogens were found to make up 42.2% of species isolated from patients suffering from bloodstream infections. ESKAPE pathogens, *Enterococcus faecium*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Acinetobacter baumannii*, *Pseudomonas aeruginosa*, and Enterobacter, are most likely to show multidrug resistance and extremely high resistance to specific drugs. These species also claim responsibility for the highest number of hospital-acquired infections, and tend to increase the duration of hospital stays in patients with bloodstream infections. Due to their resistance to many drugs in the current antibiotic arsenal, these infections are consequently difficult to treat. Yet, to create new antibiotics that could target these pathogens would be unreasonably expensive and time consuming. Novel treatments that could improve the bacteriostatic and/or bactericidal capabilities of pre-existing antibiotics are needed. Antibiotic adjuvants, nontoxic chemical compounds that target specific resistance mechanisms, show promise in combating ESKAPE pathogen infections. Investigation of targeted β-lactam antibiotics of methicillin-resistant Staphylococcus aureus (MRSA) and Staphylococcus epidermidis in combination with the lead compounds has shown increased antibiotic properties at lower concentrations. Aminoglycoside antibiotics were then investigated in combination with the same active compounds to determine if the same compounds would prove active in other classes of antibiotics. The two lead compounds did indeed potentiate antibiotic activity in aminoglycosides in several strains of MRSA and initial results in some gram-negative ESKAPE pathogens have shown potentiation. Because these infections are so difficult to treat, these compounds could revolutionize treatment of these medically relevant bacterial pathogens.

(P.2) Validation and Characterization of Zebrafish as a Model for Miscarriage

Emily Davis, James Dew and Kristin Ackerman*
Department of Biology, High Point University

Miscarriage, or “spontaneous abortion,” is a condition that affects 10%-15% of all clinically recognized pregnancies before 20 weeks gestation. Approximately 30%-60% of all conceptions will end within the first trimester, likely before a woman realizes that she is pregnant. Despite having multiple etiologies, most notably chromosomal and endocrine abnormalities, it is often too early to determine the exact cause of the miscarriage. Considering the physical and ethical implications of performing experiments on human patients, biomedical research has typically focused on mammalian vertebrate models, such as mice, rats, and primates. Modeling spontaneous abortion this way can provide more insight into possible causes of miscarriage, as well as provide a means of prevention. Zebrafish (*Danio rerio*) pose significant advantages over other animal model systems. In contrast to mammalian systems, zebrafish have an external fertilization with rapid and transparent development that make them easy to pharmacologically manipulate beginning at the 1-cell stage and visualize via a traditional light microscope. The Ackerman lab has preliminary data to indicate that the activation of the cholinergic system via nicotine exposure is protective against spontaneous mortality at 24 hours after fertilization. This data revealed accelerated embryonic development and increased expression of nicotinic acetylcholine receptors. My goal is to identify whether early nicotine exposure protects against or merely delays the development of morphological defects that likely cause spontaneous mortality. Zebrafish embryos were exposed to nicotine (0, 0.1, 1, 10 and 100 μM) at 1-cell and blastomeric mitosis, gastrulation, neurulation and mortality rates were quantified.

(P.4) CRISPR-Cas9 as a Genetic Tool for Studying MRSA Antibiotic Resistance

Gianna DiGiacomo, Victoria Federico, Amaiya Anthony, and Heather Miller*
Department of Chemistry, High Point University

Methicillin-resistant *Staphylococcus aureus* (MRSA) is a major human pathogen responsible for a variety of infectious diseases. Its defense mechanisms have allowed it to become resistant to beta-lactam antibiotics commonly used. Previous research has found that the serine-threonine kinase, Stk1, is a master regulator of antibiotic resistance in S. aureus. Our lab has been successful at identifying small molecule inhibitors of Stk1 that potentiate beta-lactam antibiotics. Therefore, we set out to create stk1 deletion mutants that can be used as genetic tools to further study Stk1 function. To accomplish this, we used the CRISPR/Cas9 system, which has only previously been used previously to edit two clinically relevant strains of MRSA. To insert the CRISPR plasmids into our chosen strains, an intermediate laboratory strain, RN4220, is required. This strain can accept plasmids purified from E. coli due to its lack of defense mechanisms that other *S. aureus* strains possess. Once the RN4220 cells were made electrocompetent, the CRISPR plasmids were electroporated into the cells. Verification of stk1 deletion was performed using PCR and DNA sequencing. If any of these contain the desired gene deletion, the plasmid will then be purified and electroporated into clinically relevant strains of MRSA. Preliminary data will be presented. The creation of these tools will allow for additional gene deletions or edits to be made in *S. aureus* genomes in the future and will allow us to gain a better understanding of how Stk1 functions in the regulation of antibiotic resistance.

(P.5) Development of Methodology for the Synthesis Of Novel Carbazole Compounds Utilizing the Photo-redox Chan-Evans-Lam Reaction

Jessica Emrich and Meghan Blackledge*
Department of Chemistry, High Point University

Carbazoles have recently become an interesting scaffold to work with in the field of medicinal chemistry. There are a limited number of commercially available carbazole derivatives and the current synthesis methods are cost and time intensive. We are interested in synthesizing decorated carbazoles to increase our library. This was done through a two-step synthesis process involving the photo-redox Chan-Evans-Lam coupling reaction. This combines an aniline and boronic acid under blue LED lights to create a substituted diphenylamine. This compound then undergoes a cyclization process to create a carbon-carbon bond, which finalizes the carbazole parent. The Chan-Evans-Lam reaction has been optimized to observe what can be added to decorate the exterior of the carbazole parent. Thus far a number of reactions have been created through the initial coupling reaction and patterns are emerging with selectivity for positions and groups, such as halogens attaching in better yields than more polar groups. Synthetic details and the optimized methodology will be presented, as well as biological data (if available) for completed compounds. In the future, once these compounds are confirmed and characterized, they will be sent for biological testing. Other future experiments will be observing a different set of methodology for creation of the carbazole.

(P.6) Synthesizing Antibiotic Adjuvants From Novel Scaffold, 4-bromo-9H-carbazole, via N-alkylation and Epoxide Tail Addition

Sophia Gregory, Ashley King and Meghan Blackledge*
Department of Chemistry, High Point University

Antibiotic resistance is a growing problem in the world and unfortunately, new drug development takes decades. Therefore, we are developing antibiotic adjuvants that target antibiotic-resistant mechanisms and work in conjunction with preexisting ß-lactam antibiotics. The Blackledge lab has identified 4-bromo-9H-carbazole as an antibiotic adjuvant in MRSA, potentiating the activity of several ß-lactams. However, this molecule's low molecular weight limits its activity, potency, and bioavailability. We hypothesize by synthesizing an effective method of derivatizing this molecule, its biological activity, adjuvant potency, and bioavailability will be improved. N-alkylation of our lead carbazole is being utilized in further derivatization of the molecule. We have attached an epoxide with a short linker to the carbazole nitrogen. Opening the epoxide with a variety of nucleophiles afforded products featuring an alcohol, to improve solubility and bioavailability, and other functional groups to improve target binding and facilitate a structure-activity relationship study at this location. Synthetic methodologies and preliminary biological data will be discussed.

(P.8) Albendazole Induces Apoptosis in PC3 Prostate Cancer Cells

Jonathan Jansma, Andrew Gustetic, and Kevin Suh*
Department of Biology, High Point University

Drug repurposing, also known as drug repositioning or drug reprofiling, is an approach to accelerate the drug discovery process through the identification of a novel clinical use for an existing drug that is approved for another use or withdrawn because of adverse effects. Benzimidazole derivatives such as albendazole and fenbendazole are used for the treatment of a variety of parasitic worm infestations. Recently, these drugs gained considerable attention because of their unexpected effects against cancer. Few reports showed that deworming drugs have microtubule depolymerizing activity towards human cancer cells. In this study, we found that albendazole can inhibit the proliferation of PC3 prostate cancer cells by inducing programmed cell death which was measured in multiple ways. We observed membrane blebbing and nuclear fragmentation, which are key characteristics of apoptotic cell death, in PC3 cells treated with albendazole. Cleavage of PARP protein occurs during the execution phase of apoptosis which increased when treated with albendazole in a dose-dependent manner. Upon apoptotic stimulation, channels are formed in the mitochondrial membrane for cytochrome C release to activate caspase pathway which eventually leads to cell death. This channel formation can be inhibited by anti-apoptotic proteins such as Bcl-XL. Treatment of cells with the drug downregulated the expression of Bcl-XL indicating that albendazole facilitates the formation of lethal pores to activate mitochondrial apoptosis pathway.

(P.9) Correlating the Relationship Between Soil Nutrient Production and Autumn Colors Using ArcGIS

Libby Johnson, Brett Woods, Nicole Hughes*, Christian George*
Department of Biology, High Point University

Leaves of temperate deciduous trees range from yellow to bright red in autumn. Red coloration comes from pigments called anthocyanins, which have been hypothesized to protect leaves from high light stress and warn herbivores of low nutrient quality. Several studies have shown that there are more red-leafed species in eastern North America (ENA) than Europe and East Asia, which has been attributed to higher irradiance and more dramatic temperature changes in autumn. Because low leaf nitrogen is known to increase anthocyanin production in many species, and soil properties affect nitrogen availability, we hypothesized that soils of ENA might also be lower in nutrient quality than Europe and East Asia. To test this hypothesis, we used ArcGIS to compare soil characteristics like pH, cation exchange capacity, nitrogen, phosphorus, and organic carbon content in the temperate deciduous forests of the three regions. Consistent with our hypothesis, soils of ENA were significantly poorer in terms of all tested soil nutrient values than in Europe and East Asia. It can be inferred that red leaves in fall may be an adaptation to saving nutrients from one season to the next. Our next steps will be to use ArcGIS to measure soil characteristics of a single clade of North American oaks (genus Quercus), to test the hypothesis that red-deciduous species are native to regions with poorer soils than yellow-deciduous species.Correlating the relationship between soil nutrient production and autumn colors using ArcGIS.

(P.10) Understanding the Fluorescent Properties of Fluorescein Amide Derivatives

Rory King, Keir Fogarty* and Pamela Lundin*
Department of Chemistry, High Point University

Fluorescein is a xanthene dye that has applications in fields, such as forensics to detect trace amounts of blood, as a radiopaque medium, and for eye stain tests to check for corneal scratches. The overall fluorescent properties of fluorescein is determined by the solution pH. In a basic solution, fluorescein is charged and in its open form with strong fluorescence at the 500 nm wavelength. In an acidic solution, fluorescein is in its neutral, closed form with very little fluorescence. While ester derivatives of fluorescein are known, amide derivatives have not been reported in the literature. In this presentation, we will present our work on the synthesis and optical properties of amide derivatives of fluorescein utilizing different amine precursors. The change in properties of these novel fluorescein derivatives will be compared to the amide analogs of the fluorescent xanthene dye rhodamine-B.

(P.11) Construction of an Instrument Capable of Two-color Fluorescence Correlation Spectroscopy

Andrew Lawrence and Keir Fogarty*
Department of Chemistry, High Point University

Fluorescent photoswitches are molecules that have the ability to exhibit one type of fluorescence when excited with a particular wavelength of light, as well as a second type of fluorescence or lack thereof when excited by a second wavelength of light. These are important because of their potential use for digital 3D display technology as well their use in improving optical and color technology. These provide a way to make functional displays that can be viewed in 360 degrees, which could be utilized in many practices including military and medical fields. The Lundin lab has created a type of rhodamine spirolactam that exhibits two types of fluorescence, which can either fluoresce blue or orange, depending on the ionization state. This is dependent on the workup of the molecule, where the solvent and purification conditions determine the color. To characterize this behavior, an instrument must be built for fluorescence correlation spectroscopy (FCS) to study the kinetics of these dimers on the single molecule level. FCS monitors the fluorescence of single molecules that traverse a laser focus, by detecting the light emitting from molecules in avalanche photon-diodes. The color of light emitted helps determine kinetics of the isomerization reactions of these molecules. If these kinetics can be understood, it could become possible to control the reaction of this spirolactam to intentionally switch between the types of the molecules producing either blue or orange light on command.

(P.13) Evaluation of Surface Modification and Small Molecules as Inhibitors of Methicillin-resistant *Staphylococcus aureus* (MRSA) Biofilm Formation

Margaret Mauer, Luke Akers, Rachel Day, Pamela Lundin* and Meghan Blackledge*
Department of Chemistry, High Point University

According to the CDC, Methicillin-resistant *Staphylococcus Aureus* (MRSA) accounts for over 300,000 yearly hospitalizations. With no new treatments for these infections on the horizon, MRSA poses a major threat to the lives of millions. Many of these infections develop as a result of biofilms. These films evade treatment by forming layers of bacteria and extracellular matrix that resist breakdown and cause recurring infection. Biofilms represent one of the most common causes of medical device failure as bacteria can easily adhere to the polymers used to make these devices. Our overall goal is to develop novel methodologies and therapeutics to prevent and disperse bacterial biofilms. One aspect of this project evaluated whether chemically modifying the surface of polydimethylsiloxane (PDMS), a polymer commonly used in medical devices, could inhibit MRSA biofilm formation. Additionally, small molecules were examined as potential inhibitors of MRSA biofilm formation. We utilized crystal violet staining to evaluate and quantify biofilm formation in the presence of either small molecule inhibitors or surface-modified PDMS. Through this quantification we were able to determine that modification with long alkyl tails has the capability of inhibiting MRSA biofilm formation while shorter alkyl tails promote growth. In addition to this finding, two small molecule biofilm inhibitors were identified with the strongest molecule inhibiting biofilm formation with $MBIC_{50}$ values ranging from 5-10 μM.

(P.14) Fabrication of Structures on Surfaces: From the Macro to the Molecular Scale

Gia Perdikis and Brian Augustine*
Department of Chemistry, High Point University

Controlled 2-D fabrication of materials is an important technology in the field of materials science, including applications to nanotechnology and molecular visualization. Using methods of sewing, milling, photolithography, microcontact printing (μ-CP), and nanolithography we were able to pattern various features onto substrates with size ranges from the macro- to the nano-scale. We are interested in determining the capabilities that our lab possesses in preparation for the nanotechnology course that will be available to undergraduate students this upcoming fall. The experiments performed were successfully accomplished in absence of a clean room. With use of a spin coater and an ultraviolet floodlight, we were able to successfully pattern μm-sized features onto Si substrates using a process called photolithography. Subsequently we were able to use the dynamic contact mode (AC tapping mode) capability of the atomic force microscope (AFM) to determine that we achieved printing 10-20 μm minimum features onto silicon substrates. Use of a scanning electron microscope (SEM) will determine whether we the lithography successfully cleared exposed photoresist to the Si substrate. The AFM also has lithographic capabilities which were used to etch 150 nm features onto PMMA thin films cast onto Si substrates. PMMA films with molecular weights of 15,000 and 125,000 kg/mol were used as an etching layer. Through μ-CP of hexadecane thiol (HDT) onto gold-plated Si substrates, we determined the optimal length of time the HDT needs to effectively print onto the substrate. Precise parameters used for each experiment to produce conclusive results will be presented.

(P.15) Isolating the Opened and Closed Forms of a Rigid Dimer of the Fluorescent Dye Rhodamine B

Angelina Pierre, Brandy-Fey Stratton, Keir Fogarty, and Pamela Lundin*
Department of Chemistry, High Point University

Rhodamine B is a fluorescent dye based on a xanthene core that can be used as a staining reagent a biomarker or the basis of fluorescent sensors for pH changes and metal ions. Rhodamine B exhibits dynamic activity as the form it adopts depends on the acidity or basicity of its environment, which in turn impacts the fluorescent properties it exhibits. Under basic conditions, Rhodamine B is in the closed form with little conjugation and so it exhibits a low level of fluorescence. In an acidic environment, Rhodamine B is in its opened form and is highly conjugated, resulting in maximum fluorescence. due to its opened form. We are interested in how the creation of Rhodamine B dimers may impact the optical properties of this dye. We have synthesized a rigid dimer of Rhodamine B using a benzene linker and have confirmed its structure with ultraviolet-visible spectroscopy (UV-vis), liquid chromatography-mass spectrometry (LCMS), and nuclear magnetic resonance (NMR). We have found that the extraction and purification processes impact whether the opened or closed forms of the Rhodamine B rigid dimer is isolated. We have optimized these procedures to be able to isolate either form with high purity.

(P.16) Fabrication of Microfluidic Devices Used for Electrophoretic Separations

Anna Wohlwend, Pamela Lundin*, and Keir Fogarty*
Department of Chemistry, High Point University

Microfluidic devices are useful due to the small volumes of reagents required, along with the fact that they work as efficient analytical systems. A microfluidic device can be used with capillary electrophoresis (CE) to perform separations of chemical mixtures containing molecules of differing charge and size. The Lundin lab synthesized rhodamine B dimers (RB_2) which are hypothesized to exist in three isomeric forms with different charge states (+2, +1, and 0). We therefore hypothesize that microfluidic CE (MCE) is an ideal technique for studying equilibrium mixtures of RB_2 under different conditions. Understanding the 3D resin printer along with creating the designs for the devices are a large portion of the project before testing can be done. Previous microfluidic devices that have been made are printed in two parts, a main chip with the channels and a cover chip with the wells, but the device designed in our project eliminated the need for having two separate pieces and printed it all in one. CE is used on the device because it doesn't take much time to analyze, the separation provides a higher efficiency compared to other techniques and is less expensive. Our lab hopes that our MCE will yield insights into the complex isomeric equilibrium of these dimers for characterizing the different RB_2 isomers.

Note that the following posters abstracts are cross-listed in the Oral Presentations:

- **(P.3) See Th.5 (Rachel Day and Meghan Blackledge)**
- **(P.7) See Th.6 (Brenna Ivory, Hannah Smith and Veronica Segarra)**
- **(P.12) See Th.9 (Maggie Salley, Anna Ferraro, Bailey McCormick and Nicole Hughes)**

2021 SuRPS Faculty Participation and Projects

Department of Biology

Dr. Kristin Ackerman (Neuroscience)

"Zebrafish as a model system for neuronal development and regeneration"

Using zebrafish as a model system, the Ackerman lab studies the mechanisms of nervous system development and regeneration. In humans, a number of genetic diseases and environmental factors contribute to irreversible loss of neurons including macular degeneration (leading cause of blindness in the elderly population), diabetic retinopathy, glaucoma, Alzheimer's and Parkinson's Disease (neuronal degeneration in the brain), and spinal cord degenerations. Many of these adult disorders have been linked to loss of cholinergic or dopaminergic specific neurons. Despite the fact that the cell loss can occur in different regions of the central nervous system, it remains clear that the irreversible cell death in humans cannot be overcome/cured. In contrast, zebrafish are able to regenerate cells very rapidly within the retina and rather quickly in the brain and spinal cord, allowing blind fish to regain sight within a few weeks to 2 months and a damaged brain to recover behavior within 4 months. Additionally, the adult regeneration program is thought to recapitulate cellular process involved during embryonic development. Thus, clearly understanding programs of how neurons develop (specifically how they are specified, proliferate, and differentiate) may be key to understanding regeneration. Therefore, we are using embryonic/larval zebrafish to identify the inherent processes that allow for its rapid and concise nervous system development, which can then be used as a guide to understand larval/adult regeneration. The Ackerman lab will have three studies available: 1) Transcriptional regulation of nAChR (nicotinic acetylcholine receptors) after nicotine exposure during development, 2) Expression of nAChR in the adult zebrafish brain, and 3) Dark adaptation in not necessary to drive adult regeneration in the light-damaged retina.

Dr. Carter Berry (Botany)

"Developing a mechanistic framework for how diffuse light alters tomato photosynthesis and water-use efficiency"

While plants cannot survive without sunlight, not all light is the same; both light quantity and spectral quality dramatically affect photosynthesis. However, one other key variable of light is largely overlooked: the angle of light arriving at the leaf (direct or diffuse). New research demonstrates that diffuse light can double photosynthesis while maintaining similar rates of water use. The mechanism driving this observation remains unresolved. The goal of this project is to develop a mechanistic basis of how light quality, leaf structure, and biochemistry interact to affect tomato plant productivity. This seed research will (1) compare the effect of sustained and short-term exposure to diffuse light on rates of photosynthesis and water-use efficiency, (2) determine the leaf traits that affect photosynthetic response to diffuse light, and (3) quantify the effects of sustained exposure to direct vs. diffuse light on plant growth, morphology, and fruit production. We will compare individuals of 10 tomato cultivars grown in diffuse light to individuals grown in direct light, then quantify photosynthesis and water use efficiency. We will then determine the biochemical, anatomical, and morphological characteristics related to increased photosynthesis in diffuse light. We will further investigate the effects of diffuse light on growth, fruit yield and quality, and biomass accumulation. The output from this research will enhance our eco-physiological understanding of how plants utilize light and has the potential to transform agriculture by informing trait breeding initiatives, optimizing greenhouse infrastructure, and building a foundation for us to further explore plant productivity in diverse light environments.

Dr. Christian George (Geoscience/Biology)

"Automated identification of cells using deep learning"

The goal of this project is to mechanically phenotype eukaryotic cells. Most of the characterization of cellular phenotypes in images (for instance, determining the presence and severity of cancer) uses qualitative analysis by experts. Using deep learning image analysis we want to develop quantitative, automated techniques that are capable of differentiating cells of different phenotypic categories (healthy vs damaged, eg.). Our hypothesis is that cells which have undergone differentiation due to damage, cancer, normal differentiation pathways, etc. will undergo characteristic morphological changes which then can be recognized through machine learning image classification.

Dr. Niky Hughes (Botany/Ecology)

"Characterizing anthocyanin profiles of red leaf spots associated with plant pathogens"

Characterizing anthocyanin profiles of red leaf spots associated with plant pathogens. Despite the conspicuous nature of anthocyanin pigments in plants, many questions remain unresolved with regards to their functions. For example, red spots on leaves are a common symptom associated with a wide variety of viral, bacterial, fungal, and insect infections in plants; yet, the role that anthocyanins play in this defense response is not only unknown, but has scarcely been explored. This project would use analytical techniques to profile anthocyanins in red leaf spots associated with plant pathogens, which could serve as a clue to their ultimate function. We will also isolate anthocyanins from plant matter in order to test them for possible antimicrobial activity. The Hughes lab also seeks 1-2 students to study the role of red anthocyanin pigments in plant ecology. Potential projects include: examining the role of anthocyanins in pathogen defense response, herbivory deterrence, shade adaptation, autumn leaf color change, and flower temperature.

Dr. Kevin Suh (Genetics/Molecular Biology)

"The possible role of fenbendazole in HeLa human cervical cancer cells"

Recently, fenbendazole and other deworming drugs have gained considerable attention because of their unexpected effects against cancer. Microtubule targeting agents such as Taxol have been approved as anticancer drugs and used widely as they can effectively target fast growing cancer cells by disrupting microtubule dynamics. Drugs such as fenbendazole and mebendazole are used for the treatment of a variety of parasitic worm infestations. These antihelminthic drugs also target microtubules. Even though dewormers have greater affinity for helminth tubulin, which polymerizes into long chains that form microtubules, these drugs can target mammalian tubulins. In fact, there are few reports that showed that deworming drugs have microtubule depolymerizing activity towards human cancer cells. Especially, fenbendazole (methyl N-(6-phenylsulfanyl-1H-benzimidazol-2-yl) carbamate) exhibited potent antitumor effect in both in vitro and in vivo studies. In our preliminary studies, we observed that fenbendazole inhibits growth of HeLa human cervical cancer cells. We also observed cell fragmentation and membrane blebbing, which are key characteristics of apoptotic cell death, in HeLa cells after treating with fenbendazole. In this study, we will verify our previous observation and elucidate the mechanism of anticancer activity of fenbendazole in human cervical cancer cells.

Dr. Veronica Segarra (Cell/Molecular Biology)

"Dissecting Atg27 function in yeast membrane traffic and autophagy"

Eukaryotic cells survive stress and starvation by activating a recycling process known as autophagy. Autophagy defects are observed in human disease. A promising target for emerging therapies is the membrane trafficking events leading to the formation of the autophagosome, a unique vesicle that envelops materials destined for recycling. Our research examines the function of Atg27, a protein that helps coordinate this process, using budding yeast as a model system. Atg27 is found in the membranes of the Golgi, early/late endosomes, and the vacuole. While its cytoplasmic domain ensures proper localization, the function of its large luminal domain remains unknown—although it structurally resembles proteins of the mannose-6-phosphate receptor homology (MRH) domain family, which bind N-glycans and often sort glycosylated proteins through the endomembrane system. During SuRPS 2016 and 2018, we mutated the MRH residues in Atg27 and our results showed that cells expressing MRH-abrogated Atg27 survive starvation differently than wild type. In August 2019, we published a new assay, allowing us to characterize these mutants in detail. We also discovered that MRH-abrogated Atg27 continues to localize to membrane compartments, although differently than wild type. Our research goals for SuRPS2021 focus on understanding the MRH-abrogated Atg27 defects in traffic and autophagy.

Department of Chemistry

Dr. Brian Augustine (Materials Science/Nanotechnology)

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

Thin films of poly methylmethacrylate (PMMA) can be produced with novel micro/nanostructures when they are deposited from solutions of tetrahydrofuran (THF) under specific deposition conditions. A complicated plate-like structure with large open pores can be created by spin-casting PMMA films from 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 as one would expect. 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. Taking advantage of the enhanced surface activation of the electroless pre-treatment with other vapor phase deposition techniques such as atomic layer deposition (ALD) could result in a metal-coated nanoporous material 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. Meghan Blackledge (Bioorganic)

"Drug repurposing to find and create novel compounds that inhibit antibiotic resistance and biofilm formation"

In the last twenty years, bacterial infections have reemerged as a major health threat. It is predicted that by 2050, deaths from bacterial infections will outpace those from cancer. Bacteria evade treatment through two main mechanisms: (1) development of genetically encoded resistance to antibiotics, and (2) formation of bacterial biofilms that allow the bacteria to tolerate antibiotic treatment and form a reservoir of persistent infection. The Blackledge lab is interested in identifying and synthesizing novel small molecules that can reverse antibiotic resistance and bacterial biofilm formation in medically relevant strains of bacteria. Recently, we have had success identifying amoxapine, an antidepressant, and loratadine, the active ingredient in Claritin, as compounds with the ability to "break" beta-lactam resistance in MRSA and inhibit biofilm formation in Staphylococci. To expand our work repurposing FDA-approved drugs as novel antibacterial therapies, we will be screening a library of FDA-approved compounds for activity against medically relevant strains of bacteria. In addition to searching for more lead compounds, we will be using synthetic organic chemistry to make derivatives of amoxapine and loratadine to better understand the relationship between the compound's structure and its activity in bacteria. Student researchers in the Blackledge lab have the opportunity to learn assays and techniques in both microbiology and organic chemistry, even if students have not taken these courses yet.

Dr. Keir Fogarty (Analytical/Biophysical)

"Single molecule fluorescence characterization of synthetic dyes and biomolecular complexes"

This project focuses on the utilization of fluorescence methods to characterize photo-physical properties of novel fluorescent molecules. Species will be characterized through a combination of fluorometry and fluorescence correlation spectroscopy (FCS). Fluorometry can be used to characterize absorption and emission profiles of fluorescent species. FCS measures temporal fluorescence fluctuations caused by single fluorescent molecules moving through a laser excitation volume (~10-15 L). The amplitude, duration, and frequency of these fluorescence fluctuations can yield information concerning the fluorescent molecules' brightness, mobility (diffusion rate), and concentration. For the novel fluorescent polymers, the experimental goal is to identify tailorable photo-physical properties, such as molecular brightness, which will have unique application in fluorescent-labeling applications. In addition, their complex solution-phase inter- and intra-molecular interactions can be taken advantage of in sensing applications. For instance, a species designed in collaboration between the Lundin and Fogarty labs has yielded some preliminary data which indicates promise as a possible halogen sensor in solution.

Dr. Pamela Lundin (Organic/Polymer Materials)

"Influence of self-assembled monolayer structure on film characteristics of surface grafted poly(3-hexylthiophene)"

This project aims to establish the relationship between the film characteristics of surface-bound poly(3-hexylthiophene) (P3HT) on large-scale, flat surfaces as a function of the self-assembled monolayer (SAM) structure used to initiate their growth. P3HT is a benchmark conjugated polymer, but in the literature its growth from such surfaces has proved elusive, whereas less bulky analogs such as polythiophene can be produced. We have successfully grown P3HT in our laboratory from gold and silicon oxide surfaces using a self-assembled monolayer that consists a flexible alkyl chain that is bonded through an amide to the aryl nickel(II) bromide initiator. We hypothesize that our success is due to the flexible alkyl spacer is used to create a novel structure for the formation of a self-assembled monolayer that can be functionalized with the polymerization initiator and reacted with the monomer. We propose to make analogs of our SAM in which the alkyl spacer is longer or non-existent and compare the characteristics of the P3HT films generated from these surfaces using atomic force microscopy, contact angle measurements, and X-ray photoelectron spectroscopy.

Dr. Heather Miller (Biochemistry)

"Exploring Stk1's mechanism of action in MRSA"

The role of the kinase Stk1 in MRSA virulence gene expression is poorly understood. Enhanced knowledge of Stk1 substrates and downstream genes and pathways affected by Stk1 phosphorylation would provide crucial insight into global and unintended consequences of Stk1 inhibition. The objective of this project is to expand our understanding of gene expression that is regulated by Stk1 and identify novel Stk1 substrates. Our approach to this will be to evaluate global transcriptional changes that result from Stk1 inhibition in the presence and absence of antibiotic treatment. This will quantify gene expression changes and pathways that are affected by Stk1, specifically in the medically relevant context of antibiotic treatment. In parallel to this transcriptomic approach, we will use a phosphoproteomic approach to identify novel Stk1 substrates. Upon completion, we expect that this information will provide a more complete description of Stk1's mechanism of action, identify strain-specific differences in Stk1-mediated gene expression, and describe global implications of inhibiting Stk1. Students in the Miller lab will perform techniques such as RNA purification, real-time PCR, RNA-seq, CRISPR, and SDS-PAGE.

Dr. Andrew Wommack (Organic) *"(1.) Total chemical synthesis of peptide-based kinase substrates* *(2.) Modeling nature's antioxidant"*	1) We are interested in using synthetic chemistry to generate custom peptides and peptide fragments to track phosphorylation signaling in plants. The signaling networks that we are concerned with determine how plants mobilize and utilize carbon building blocks to modulate basic functions like cell growth and alternative pathways such as production of lipids. Analytical chemical instrumentation is extensively used to both characterize the synthetic peptides and track kinase activity. This work is in collaboration with the Hicks Lab at the University of North Carolina - Chapel Hill. 2) Glutathione (GSH) is the most abundant source of redox active sulfur in our cells. To oxidatively protect complex redox active enzymes, the small GSH molecule dynamically makes and breaks bonds with the larger enzyme. Our lab has developed a reaction method to install a GSH mimic that can irreversibly bond to the larger sensitive enzyme targets. This project will explore the consequences of irreversible bonding of our GSH mimic to members of the enzyme family known as peroxiredoxins, which play a vital role in protecting the cell from oxidative damage. This work is in collaboration with the Center for Redox Biology and Medicine at the Wake Forest School of Medicine.

Department of Physics

Dr. Brad Barlow (Astrophysics) *"A photometric survey of hot subdwarf stars using NASA's TESS spacecraft"*	We are currently collecting both 20s and 2min cadence observations of more than 2000 candidate binary and pulsating hot subdwarf stars using NASA's TESS spacecraft. Some of these targets show anomalously high Gaia flux errors indicative of strong variability, and TESS light curves should help us both confirm their variability and characterize their nature. In this project we aim to download, process, and analyze TESS photometry for all hot subdwarfs monitored during Cycle 3 observations. Collectively, these light curves will help (i) permit detailed asteroseismological analyses for an unprecedented number of pulsating hot subdwarfs; (ii) greatly increase the number of known and solved binaries; (iii) determine the influence substellar objects have on stellar evolution; (iv) constrain the presence of planetary companions through precise timings; and (v) generally improve our capacity to draw a statistically meaningful picture of this enigmatic stage of stellar evolution.
Dr. Jarrett Lancaster (Computational Biophysics) *"Exploring the feasibility of predicting cardiovascular disease from mathematical stability analysis in reaction-diffusion models"*	Cardiovascular disease has long been the leading cause of death in the United States as well as a tremendous drain on healthcare resources. The aim of the proposed project is to explore a possible marker for the identification of early stages of cardiovascular disease which only requires low-resolution, non-invasive probes. A novel metric known as the reserve of refractoriness (RoR) has previously been shown to be a robust measure of overall cardiac fitness which is sensitive to subtle changes in cardiovascular health and could therefore be used to detect early stages of disease when modest interventions can improve outcomes. In the proposed project, simulations of several complex models for bioelectricity will be employed to seek insight regarding why this metric appears so robust. Additionally, the project will explore ways in which this marker's accuracy can be improved from biophysical reasoning. Specifically, the proposed project will employ a mathematical stability analysis in a variety of nonlinear models for electrical propagation to examine how subtle changes in nonlinear wave propagation can provide information about instabilities which may have relevance to overall cardiovascular health.

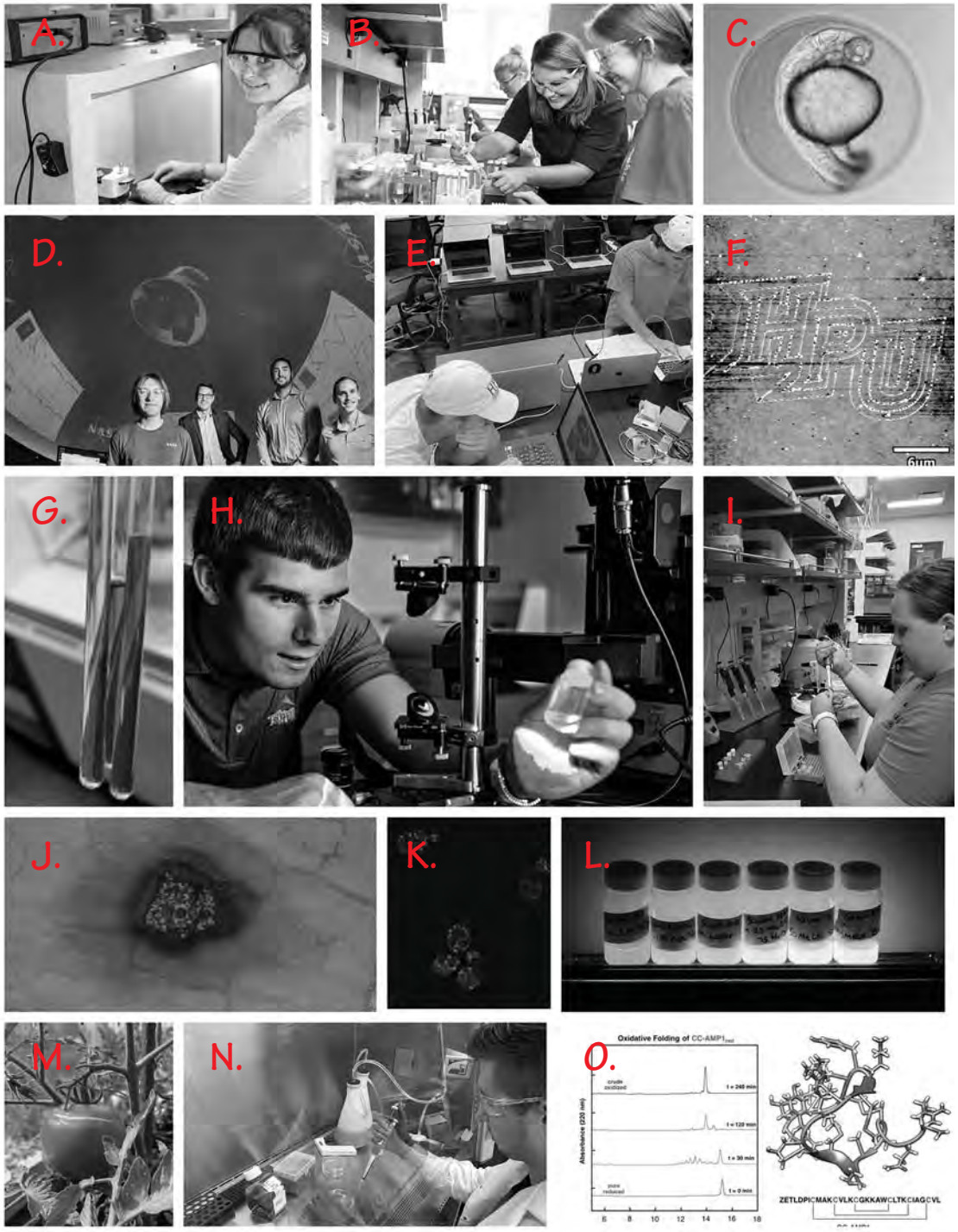
SuRPS 2021 Seminar Series

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

Date	*Name*	*Affiliation*	*Seminar Title*
Friday, June 11	**Dr. Kristen Dellinger** Assistant Professor	Joint School of Nanoscience and Nanoengineering, Greensboro, NC	*Optical Sensing for Pathogen and Biomarker Detection: SARS-CoV-2 and Beyond*
Friday, June 18	**Dr. Veronica Augustyn** Associate Professor	Dept. Materials Science and Engineering, North Carolina State University Raleigh, NC	*Water-mediated Intercalation Mechanisms in Transition Metal Oxides*
Friday, June 25	**Prof. Mark Peifer** Michael Hooker Distinguished Professor	Department of Biology University of North Carolina at Chapel Hill	*Cell Adhesion, Cytoskeletal Regulation and Wnt Signaling in Development and Disease*
Friday, July 9	**Dr. Kevin Welsher** Assistant Professor	Department of Chemistry Duke University Durham, NC	*Untethering Single-Molecule Spectroscopy and the Shape of (Intracellular) Water*
Friday, July 16	**Dr. Amanda Hargrove** Associate Professor	Department of Chemistry Duke University Durham, NC	*Deciphering Patterns in Selective Small Molecule:RNA Interactions*
Friday, July 23	**Ms. Sarah Colbert ('18)** Ph.D. Candidate	Department of Neuroscience Wake Forest University Winston-Salem, NC	*Plasticity of Retronasal Odor Perception in Young Children*

SuRPS 2021 Was Partially Supported By The Following Organizations:


PLANTS FOR
HUMAN HEALTH BUILDING
SURPS



(A.) Atomic force micrsocopy in the Augustine Lab; (B.) A day at the lab bench in the Blackledge Lab; (C.) Zebrafish embryo 24 hrs post fertilization from the Ackerman Lab; (D.) Barlow Group in the Culp Planetarium; (E.) Coding in the Lancaster Lab; (F.) HPU logo fabricated by AFM nanolithography; (G.) Fluorescent molecules synthesized in the Lundin Lab; (H.) Laser spectroscopy in the Fogarty Lab; (I.) MRSA gene expression studies in the Miller Lab; (J.) Entomosporium leaf spots studied in the Hughes Lab; (K.) Fluorescently labeled yeast samples from the Segarra Lab; (L.) Fluorescent samples from the Lundin/Fogarty Labs; (M.) Tomato cultivar grown in controlled light chamber in the Berry Lab; (N.) PC3 prostate cancer cells grown in the cell culture facility from the Suh Lab; (O.) Spectroscopy and molecular model of novel peptides from the Wommack Lab.