WILLAMETTE UNIVERSITY
SYMPOSIUM

SCIENCE COLLABORATIVE RESEARCH PROGRAM

...to provide selected undergraduate students the opportunity to work directly with faculty in the natural sciences...

september 14, 2018
ford hall 122

Cover photo by Michael Schiffer
Cover design by Eurydice Chen, Economics Class of ’19

Symposium on Science Collaborative Research Program
September 14, 2018
2:00-7:00 PM
Ford Hall, Room 122

Students from the 2018 Science Collaborative Research Program (SCRP) will present their work at our 23rd annual in-house symposium on undergraduate research. Students giving individual presentations have a total of 15 minutes with the expectation of around 12 minutes to deliver their prepared remarks followed by 2-3 minutes of questions. Student groups of two have 20 minutes total time and groups of three are allowed 25 minutes. You are welcome to join us for all presentations or any portion that fits your schedule and interests.

This symposium is a particularly great time for students interested in science to learn about the exciting and high caliber original research conducted by their peers in collaboration with faculty mentors. Likewise faculty, staff, and administrators can quickly learn about the most recent discoveries and scholarly progress of the research programs led by their co-workers in Olin, Collins, and Ford. The central importance of faculty-student scholarship is a well-established tradition at Willamette and is prized as one of our highest impact practices in training students for careers and lives of meaning.

This symposium contributes to Willamette's mission as we affirm that, "Teaching and learning, strengthened by scholarship and service, flourish in a vibrant campus community." We are also enacting Willamette's strategic plan, which pledges to improve overall student experience by, "Supporting an intellectual culture that includes more opportunities for student-faculty and student-student scholarly engagement across all academic disciplines in studios, laboratories, and the field, as well as in more informal settings."

In reviewing our symposium please note the diversity of research topics and the range of faculty and student participants across the Departments of Biology, Chemistry, Computer Science, Environmental and Earth Sciences, Exercise Science, Physics, and Psychology. Please also note much of the funding for the work you will see today stems from external grants awarded to faculty who have competed nationally to secure resources to support these

students. Finally, the program owes much to the historical support of programmatic grants from the MJ Murdock Charitable Trust and an endowment gift from John Rogers and the Mary Stuart Rogers Foundation.

If you would like to learn more about the Science Collaborative Research Program at Willamette University please contact SCRP co-directors David P. Craig (dpcraig@willamette.edu) or Chuck Williamson (jcwillia@willamette.edu) and or visit our website (http://willamette.edu/cla/additional-academic-opportunities/scrp/index.html).

Schedule of Speakers

2:00 PM……David Craig – Introductions

2:05 PM……Dayton Towata

2:20 PM……..Keeton Nance

2:35 PM…….MacKayla Carolan

2:50 PM……Katie LaChasse

3:05 PM……..Trent Jones

3:20 PM……..Reagan Dreiling

3:35 PM……..…Anna Ayala

3:50 PM……..Marcella Murillo

4:05 PM……...Break and Photo with Frank Miller

4:25 PM……Karen Espinoza & Katerin Vasquez

4:45 PM……Milla Bevens

5:00 PM……Brett Youtsey

5:15 PM……Monce Barajas Gomez

5:30 PM……Samantha Coleman & Annie Jolliff

5:50 PM……Dan Huber

6:05 PM……Angus Williams

6:20 PM……Annie Wang

6:35 PM……William Kwako

6:50 PM……..Alana Gwilym Tso

7:05 PM……Conclusion

Anna Ayala

Synthesis and Evaluation of Tetracaine Derivatives as Local Anesthetics

Advisor: Sarah Kirk
Funding: Webber Science Outreach Program

Many common medical procedures require the use of appropriate local anesthetics (LAs) that optimize safety and effectiveness. By targeting the voltage-gated sodium ion channels, LAs effectively prohibit the propagation of action potentials along neurons. Of the large family of federally-approved, accessible LAs, tetracaine is but one of the many widely-studied compounds that have proven clinical utility. A central aromatic ring, paired with either an ester or amide linked amino head group have proven essential in the drug's activity; however, cytotoxicity and moderate affinity for channel binding limit its clinical use. The physicochemical characteristics of tetracaine were altered to optimize channel binding, maximize solubility, and minimize toxicity.

This project focuses on the potential anesthetic effects of the 2-chloroprocaine amide and thioamide derivatives. The two derivatives were synthesized and characterized using Nuclear Magnetic Resonance (NMR). The derivatives were purified through High Performance Liquid Chromatography (HPLC) under 90% methanol and 10% water in ammonium acetate.

Following synthesis, purification, and characterization of the compounds, *in vivo* studies of the 2-chloroprocaine amide and thioamide derivatives are planned. The potency of the compounds will be tested in rats through administration of the drug via surgical access of the sciatic nerve. Behavioral testing and tissue analysis will provide insight into the efficiency and cytotoxicity of the compounds.

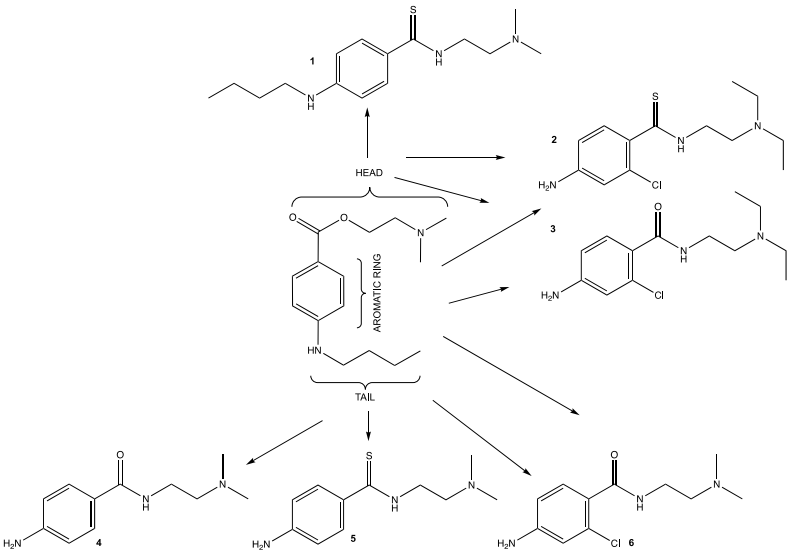


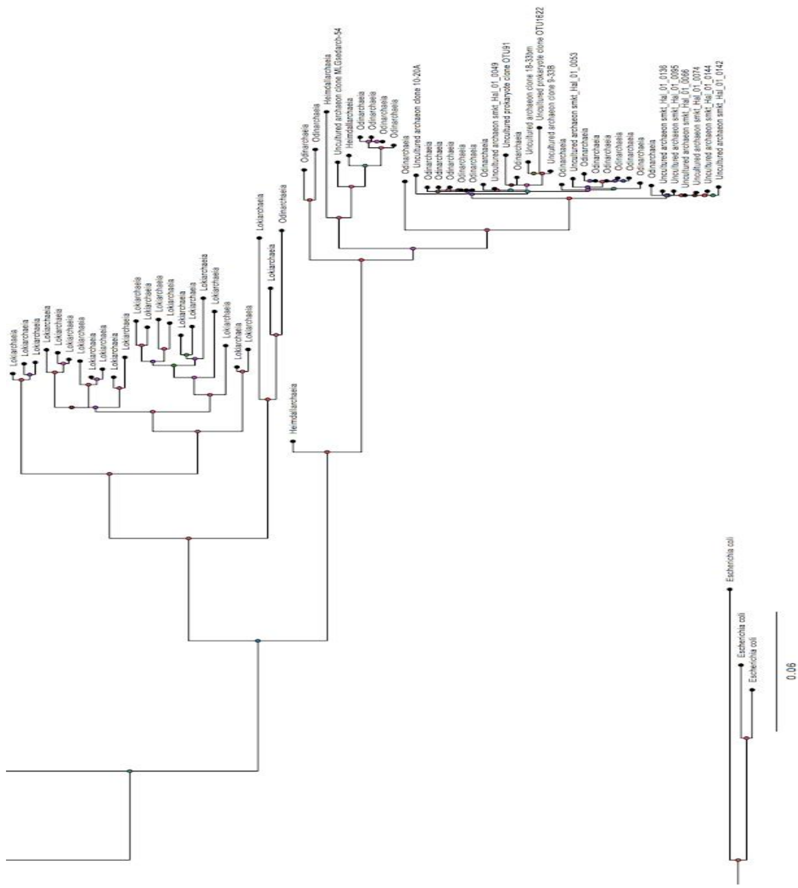
Figure 1. Alterations made to the tetracaine scaffold where synthesis targeting the head group resulted in the PABA Butyl Thioamide (**1**), 2-Chloroprocaine Amide (**2**), and 2-Chloroprocaine Thioamide (**3**) derivatives; synthesis targeting the aromatic ring group resulted in the 2-Chloroprocaine Amide (**2**), 2-Chloroprocaine Thioamide (**3**), and 2-Chlorotetracaine Amide (**6**) derivatives; synthesis targeting the aromatic ring group resulted in the PABA Amide (**4**), PABA Thioamide (**5**), and 2-Chlorotetracaine Amide (**6**) derivatives.

Monce Barajas Gomez

Developing A Specific 16S rRNA Gene Primer for Asgard Archaea

Advisor: Rosa Leon-Zayas
Funding: Wilson

The newly discovered super phylum of archaea, Asgard, is redefining the origins of the way we understand eukaryotes. Improving the methodology of targeted identification of this group of organisms has been the focus of this research. Asgard archaea has limited to no published primers for its specific amplification from environmental samples. Software tools such as Primer3, Primer-BLAST were used to design Asgard specific primers. To assess the primers ability to amplify Asgard archaea 16S rRNA genes in sediment samples, experiments will continue to be conducted against samples with known populations of Asgard archaea. This process has included running the several PCR protocols to improve the efficiency of the primer and verifying its amplification through gel electrophoresis testing. Our developed primer will then be used to develop microscopy protocols to visualize Asgard cells within environmental samples.



Phylogenetic Tree of Uncultured Odin Archaea
This figure represents the phylogenetic tree of the uncultured Odin archaea that were picked up by the developed asgard specific primer through Primer-BLAST. The uncultured Odin archaea are modeled with other Asgard archaea to determine their relationship and primer success.

Milla Bevens

What's in the Fiji Water?: An Investigation of Marine Microorganisms in Fiji Sediment for the Discovery of Novel Pharmaceuticals

Advisor: Rosa León-Zayas
Funding: SCRP

A variety of marine microorganisms are capable of producing secondary metabolites. Several enzymes involved in secondary metabolism are utilized for their pharmaceutical applications, including polyketide synthases (PKSs). These PKS enzymes catalyze the production of some secondary metabolites that harbor potent anticancer and antimicrobial properties. In the León-Zayas lab, research efforts have been focused on uncovering PKS encoding genes in Fiji sediment samples. DNA was extracted from sediment samples and PCR assays targeting the PKS genes were executed. The search for successful primers has been narrowed to two primer sets. From this work, we have evidence that the two primer sets can successfully amplify PKS genes. The identification of successful primer candidates will enable the amplification of PKS genes in other Fiji sediment samples, as well as marine sponge samples. This will allow for the implementation of MinION sequencing for the discovery of PKS derived pharmaceuticals.

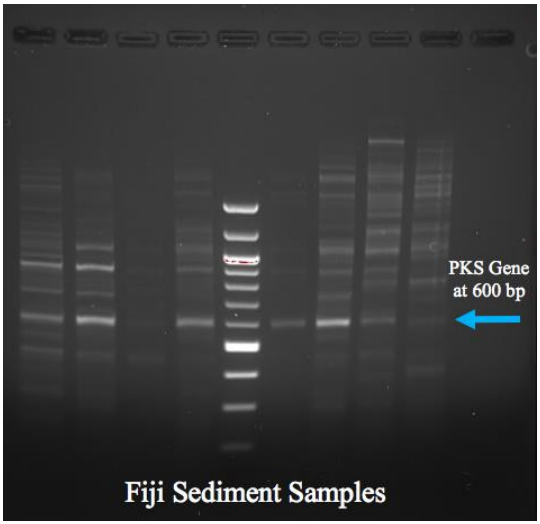


Figure 1. This gel depicts non-degenerate primers f3/r3, which successfully amplified the PKS gene located at ~600 base pairs.

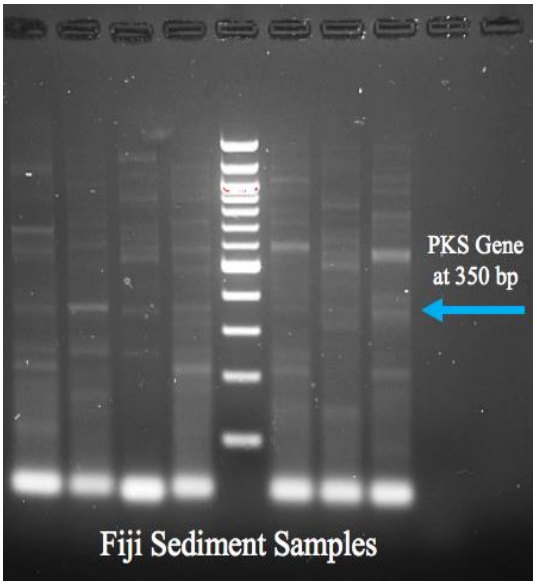


Figure 2. Amos primers are illustrated in this gel image. The Amos primers exhibit successful amplification of the PKS gene at ~350 base pairs.

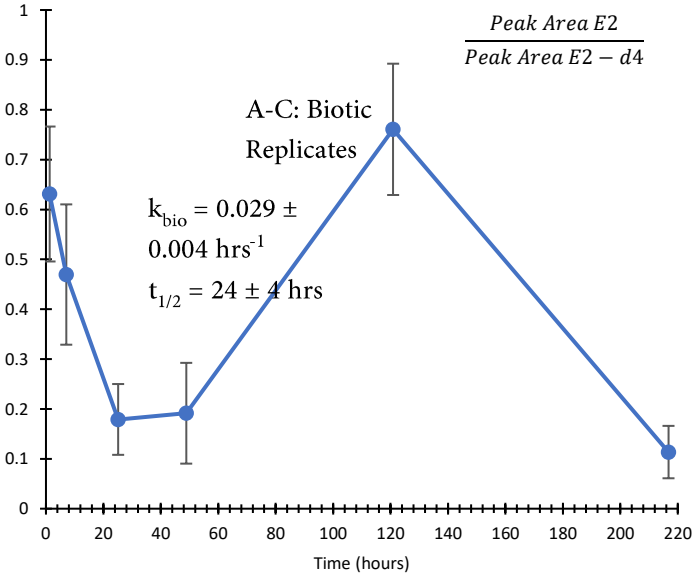
MacKayla Carolan

Quantifying the Fate of 17β-Estradiol in the Willamette River at Environmentally Relevant Concentrations

Advisor: David Griffith

Funding: National Science Foundation

Estrogens are potent endocrine disrupting chemicals that are excreted by vertebrates and can have negative effects on aquatic organisms at extremely low concentrations. Such effects in fish include feminization and an inability to reproduce. Estrogens are commonly found in wastewater treatment plant effluents and natural waters, yet the environmental fate of these compounds are poorly characterized at environmentally relevant levels. This study aimed to quantify a biodegradation rate constant for 17β-estradiol (E2) in Willamette River water at environmentally relevant (ng/L) concentrations using microcosms containing river water, sediment, and E2 (50 ng/L). Following solid phase extraction, time course samples were analyzed by liquid chromatography tandem mass spectrometry (LC-MS/MS) to quantify estrogen concentrations. We found that E2 biodegradation obeyed first order kinetics with a half-life ($t_{1/2}$) of approximately 24 hours. An increase in estrogen content at 120 hours was negatively correlated with microbial activity as measured by ATP abundance, though the underlying cause for this observation remains unclear. Biodegradation rates determined here are in agreement with a previous study of E2 biodegradation ($t_{1/2}$ = 36 h; 50 ng/L E2) in English rivers, but fivefold faster than E2 photolysis rates ($t_{1/2}$ = 135 h) in Willamette River surface water. These findings suggest that biodegradation is an important removal mechanism for E2 in sewage-impacted rivers.


$\frac{Peak\ Area\ E2}{Peak\ Area\ E2 - d4}$
A-C: Biotic Replicates
k_{bio} = 0.029 ± 0.004 hrs^{-1}
$t_{1/2}$ = 24 ± 4 hrs
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
20
40
60
80
100
120
140
160
180
200
220
Time (hours)

Samantha Coleman & Annie Jolliff

Comparing Bee Communities in Urban and Rural Environments

Advisor: Briana Lindh

Funding: Biology Endowment Fund & Webber Science Outreach Program

Abundance of both native bees and plants are declining due to habitat loss, fragmentation, and non native competitors. Through the introduction of buildings, roads and lawns, urbanization reduces the availability of food and nesting habitat for bees. The introduction of European honey bees is also suspected to have caused declines in native bee populations due to competition. We predicted that urban environments would have lower abundance and diversity of native bees than rural environments due to lack of native plants which provide floral resources. We surveyed a total of six field sites in and around Salem, Oregon, visiting weekly in May through July 2018. Sites varied in degree of urbanization, ranging from an urban neighborhood to Zena. During each visit we spent 4-5 hours walking a set route and recording the number and types of bees seen, along with the plants the bees were seen on. When we could not identify a bee visually, we caught a specimen, put it on ice, took detailed photos and then released it. The urban and rural bee communities were different from each other, while large parks had intermediate communities. Native *Lasioglossum* were more abundant in rural settings, most often foraging on exotic false dandelion. The native *Bombus* genera were often found on exotic Himalayan blackberry, which is also abundant in rural sites. At all sites, non-native plant species tended to attract more native bees, not necessarily because the bees preferred them but because they were much more abundant than native plants.

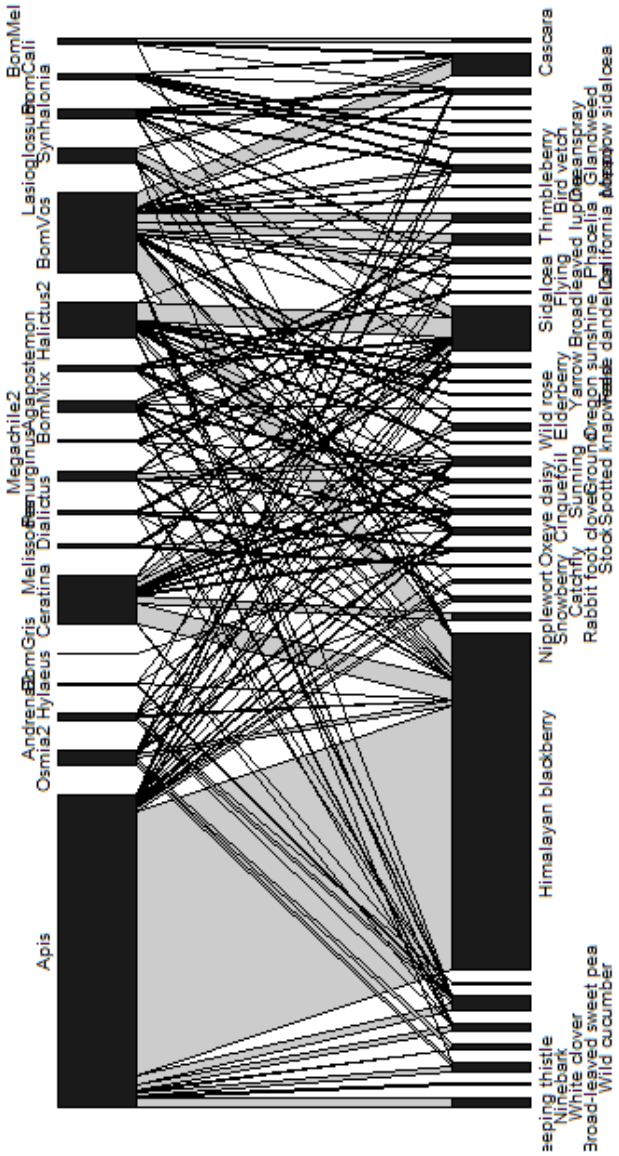


Figure 1. Pollinator network for Minto Island Park in May and early June 2018. Upper rectangles are bee species, with size reflecting the number seen during three visits to the site. Lower rectangles are plant species, with size determined by number of visits to that species.

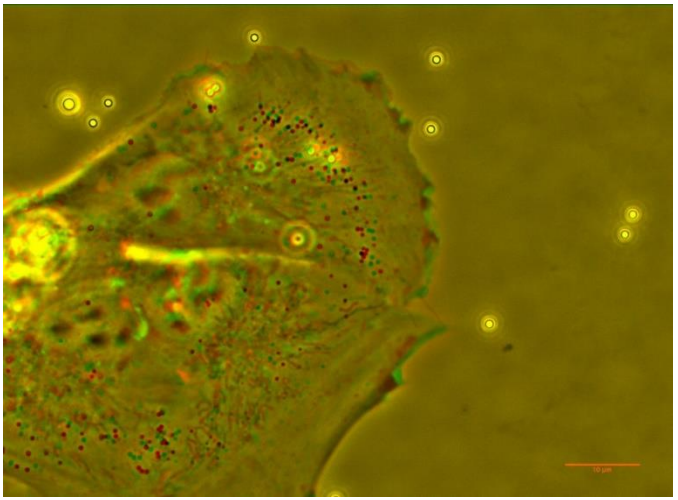
Reagan Dreiling

Phagocytosis of Photoreceptor Outer Segments by Retinal Pigment Epithelial Cells

Advisor: David Altman

Funding: Webber Science Outreach Program

The retinal pigment epithelium (RPE) is a cellular layer adjacent to the rod and cone cells of the eye. The latter sensory cells shed waste in the form of photoreceptor outer segments (POS), which the RPE then internalizes and degrades. Prior studies have established that the motor protein myosin-VI is involved in nonspecific phagocytosis of fluorescent microspheres by a human RPE primary cell line (ARPE-19). I sought to narrow the research to a more specialized phagocytosis of microspheres coated in POS in order to approach physiological conditions of the RPE. I used single particle tracking to analyze the motion of the POS-microspheres in control ARPE-19 cells as well as cells that had been transfected to express a dominant negative myosin-VI lacking motor activity. Results from control experiments indicate that the pathway for transporting POS is distinct from the nonspecific pathway that was explored in prior research. While preliminary results do not yet indicate a clear difference between control cells and cells expressing the dominant negative motor, more data are necessary to validate this.

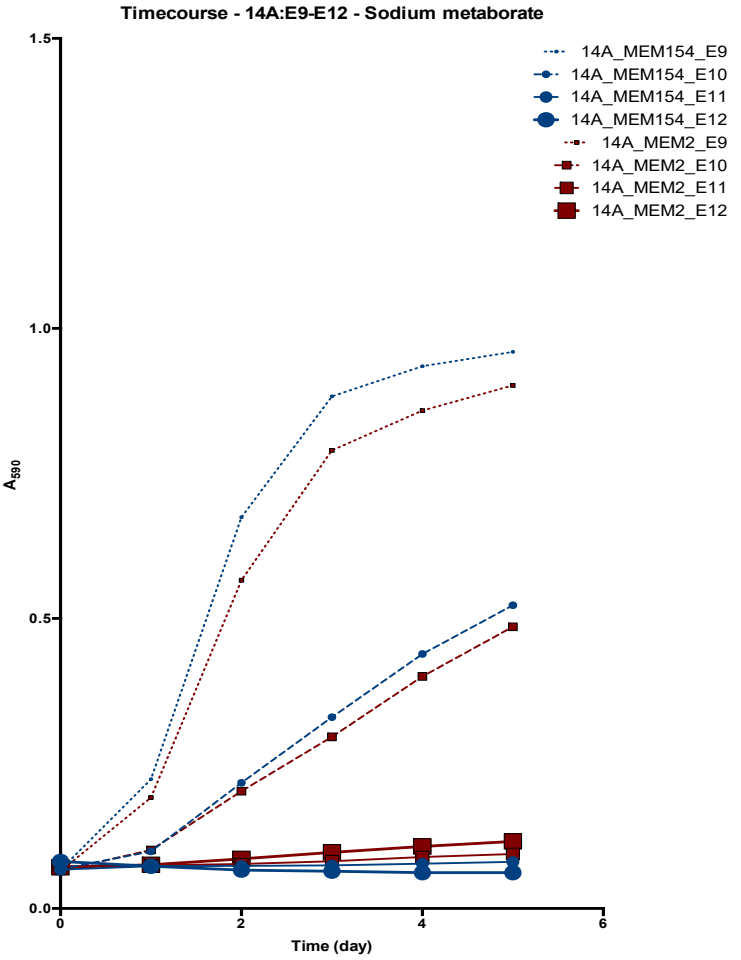


Karen Espinoza & Katerin Vasquez

Polymorphism in TonB Dependent Receptors Affects Nutrient Transport and Stress Management in *Caulobacter crescentus*

Advisor: Melissa Marks
Funding: SCRP

Caulobacter crescentus, is a freshwater gram-negative bacterium that thrives in nutrient poor environments and is a model organism for studying bacterial nutrient transport systems. *Caulobacter crescentus* strains that have polymorphisms in two TonB dependent receptors (TBDRs) proteins survive differently in mid-stationary phase. In this study, we examined the phenotypic variation in survival curves, chemical sensitivity, and gene expression between *C. crescentus* strains with polymorphisms in two TonB-dependent receptors (TBDRs). Preliminary phenotype microarray analysis demonstrates that out of 144 conditions tested, variation in metabolic capacities and chemical sensitivity between these strains were observed in the presence of chelating agents (EDTA and EGTA); suggesting a difference in how these strains detoxify or utilize metal ions as important micronutrients. While TBDRs are diverse, many have shown to transport metal ions that serve as cofactors for enzymes involved in managing oxidative stress. Therefore, the drastic difference in mid-stationary phase survival may derive from their physical ability to manage oxidative damage. To further investigate this hypothesis, transcriptome analysis by sequencing cDNA with Nanopore MinION technology will identify differences in gene expression between strains. Together, the chemical sensitivity and transcriptome profiles can identify which substrates and biochemical pathways are differentially used by these strains during different growth phases. Also, variation in nutrient acquisition may cause consequences for cellular homeostasis and survival. Furthermore, these findings will increase our understanding of how nutrient transport and utilization contribute to the physiological adaptability of *Caulobacter crescentus*, and elucidate their biological importance in helping bacteria thrive in low nutrient environments.


Timecourse - 14A:E9-E12 - Sodium metaborate
14A_MEM154_E9
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14A_MEM2_E11
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0
2
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Time (day)

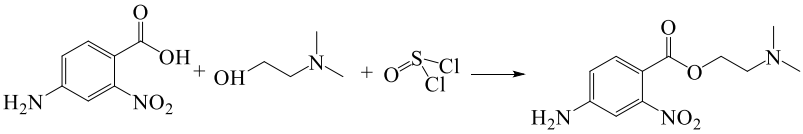
Alana Gwilym Tso

Derivatives for the Treatment of Retinitis Pigmentosa

Advisor: Sarah Kirk

Funding: Murdock College Research Program for the Life Sciences

Retinitis pigmentosa (RP) is a category of genetic mutation disorders that cause cells to breakdown in the retina of the eye. One of the genetic mutations causes unregulated cyclic nucleotide-gated (CNG) channels to remain open and allow calcium ions to flood into the cell, breaking it down. With the loss of cells, there is a loss of peripheral and night vision, leading to blindness. Through previous studies, an aesthetic called tetracaine has shown potential as a CNG channel blocker, slowing the effects of RP, but with lower affinity and selectivity than ideal. By synthesizing derivatives of the tetracaine structure, the Kirk lab hopes to find one with greater affinity to the CNG channels that will block excess ions from entering the cell. Past research shows that electron withdrawing groups are beneficial to the structure but a nitro substituent in the meta position had poor binding. A derivative with the nitro in the ortho position, 2-nitro-octylcaine, was synthesized to assess the binding in CNG channels. Multiple synthesis methods were attempted and the intermediate structure was successfully made but with a low percent yield. Further optimization of the reaction will be required.

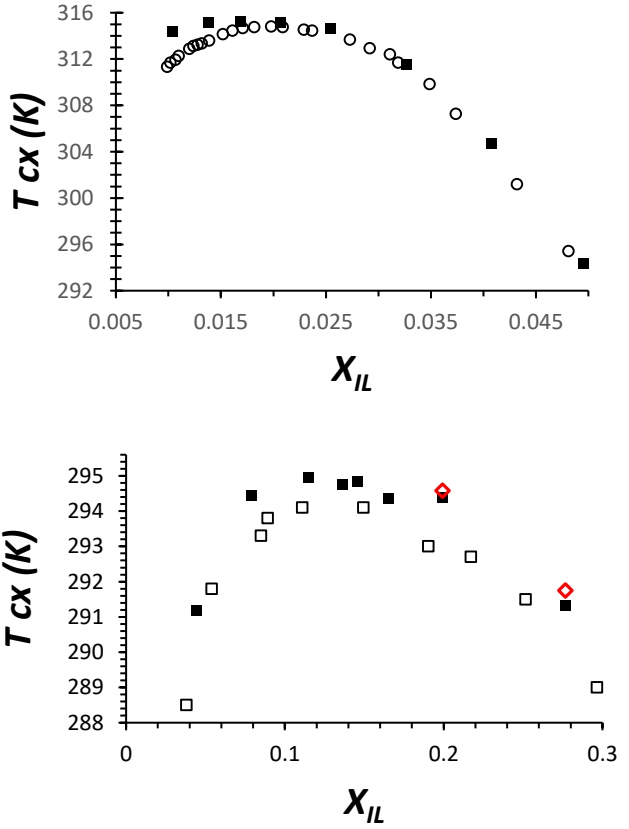


Dan Huber
Exploring Pre-Transition Droplet Formation in Binary Liquid Systems Involving an Ionic Liquid

Advisor: J. Charles Williamson
Funding: American Chemical Society Petroleum Research Fund (55088-UR10)

Studying the behavior of liquid-liquid systems provides integral information for purification and extraction processes found in chemical industry. Laser light scattering studies revealed a small droplet formation anomaly, known as pre-transition droplet formation (PTDF), about 0.1 K above the coexistence curve boundary. This highly reproducible behavior observed on one side of the coexistence curve suggests that a second phase transition may be occurring and indicates a possible third phase in systems previously considered to be binary. PTDF has yet to be observed in any binary system that contains an ionic liquid component. Ionic liquid systems have gained considerable attention due to their electrochemical properties and potential as "green" solvents, but more binary systems must be studied to fully understand their behavior across the entire coexistence boundary. Coexistence curves of four binary liquid systems containing an ionic liquid ($[C_2mim][NTf_2]$ + 1-propanol; $[C_4mim][BF_4]$ + aniline; $[C_6mim][BF_4]$ + water; and $[C_{10}mim][NTf_2]$ + benzene) were measured by varying temperature as a function of sample composition. The synthetic method of sample preparation was used, and eight samples were made for each system to span the desired composition range. A laser light scattering technique was employed to explore PTDF occurrence in these systems by collecting scattered light data at 90° and 2° to track sample opalescence and droplet scattering respectively. Contrary to previous reports in the literature, the $[C_4mim][BF_4]$ + aniline system exhibited complete miscibility over a composition range of X_{IL}=0.2 to 0.5 and a temperature range of 12 °C to 68 °C. A critical composition for the $[C_6mim][BF_4]$ + water system was found to be $X_{IL,c}$=0.0445. A coexistence curve could not be constructed for this system due to an apparent degradation process that caused a constant decline in transition temperature at a rate of roughly 0.1 K every ten minutes. PTDF was still visually observed in two of the prepared samples. The coexistence curve for the $[C_{10}mim][NTf_2]$ + benzene system agreed well with past literature and a critical composition and the critical point was found to be $X_{IL,c}$=0.0190 and T_c=42.11 °C. $[C_2mim][NTf_2]$ + 1-propanol was the only stable system to exhibit PTDF behavior

within its range of compositions. The critical point was found to be $X_{IL,c}$=0.1306 and T_c=21.64 °C. A larger set of eighteen [C_2mim][NTf_2] + 1-propanol samples have been prepared to further characterize PTDF in this system.



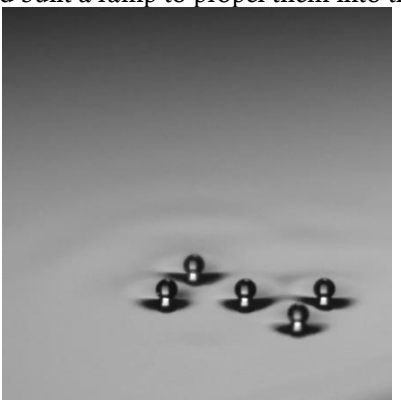
Coexistence curves for the [C_{10}mim][NTf_2] + benzene (left) and [C_2mim][NTf_2] + 1-propanol (right) binary systems were collected by varying temperature as a function of composition. Data collected by the Williamson lab (▪) for the [C_{10}mim][NTf_2] + benzene system agreed well with data collected by Szydlowski *et al.* (○). Data collected for the [C_2mim][NTf_2] + 1-propanol system (▪) was considerably noisier in comparison, but still followed trends observed by Heintz *et al.* (▫) reasonably well. Droplet formation temperatures (◊) for samples that exhibited PTDF are shown in the [C_2mim][NTf_2] + 1-propanol system.

Trent Jones

Producing Bouncing Oil Droplets to Macroscopically Model Single-Particle Diffraction

Advisor: Daniel Borrero-Echeverry
Funding: SCRP - Mary Stuart Rogers Foundation

The purpose of this project is to further investigate the extent to which the behavior of bouncing droplets is analogous to quantum systems. We will do this through experimentally modeling single-particle diffraction with bouncing oil droplets by sending them through single slit barriers of varying slit widths. This research aims to replicate a theoretical study produced by Harris and Bush in 2017 that disputes the first evidence of quantum-like behavior in bouncing droplets. This evidence was produced by Couder and Fort in 2006 who found the diffraction pattern of bouncing droplets sent through single and double slit barriers to resemble single-particle interference. Harris and Bush's theoretical study suggests that the diffraction pattern of bouncing droplets doesn't resemble that of quantum particles, but rather that the droplets' angles of emission is directly dependent on their impact parameter with the slit. As the slit width is a key parameter in investigating this relationship, this study will fill the gap in Harris and Bush's study by reproducing this theoretical study experimentally to either verify or refute their conclusion. In preparation for this experiment, we set up a CO2 laser and a galvanometer that will allow us to alter the wave field of our fluid bath to propel droplets in a desired direction. We also constructed a steel mount to stabilize and level our setup. Lastly, we improved upon an existing droplet generator in order to produce droplets of a consistent size and built a ramp to propel them into the fluid bath.

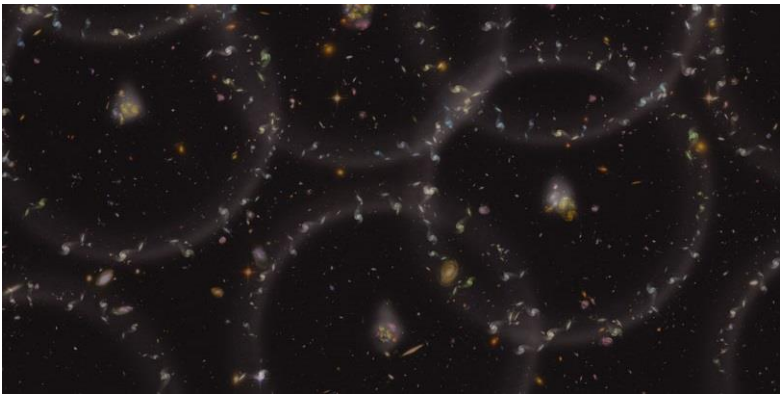


William Kwako
Looking for the BAO Signal in the 2MRS Using the Wavelet Transformation

Advisor: Rick Watkins

Funding: Murdock Charitable Trust College Research Program for the Life Sciences

We aim to search for and analyze the baryon acoustic oscillation (BAO) signal in the 2MRS (2MASS redshift survey) using a density field created by cosmographer Brent Tully. BAOs cause thin shells of galaxies to be imprinted on the galaxy distribution, and thus, are findable in our data set. Utilizing a wavelet transformation, first proposed by P. Arnalte-mur et al in 2012, we can search for the location and frequency of BAOs. By convolving any point in our data set with a wavelet that has compact support, we create a function that returns values based on how well any region of space matched the density distribution of a BAO, with a higher value indicating a higher correlation. Identifying locations in our data set with both a high density and a high matching parameter yields points that are the most likely to correspond to BAO signals.



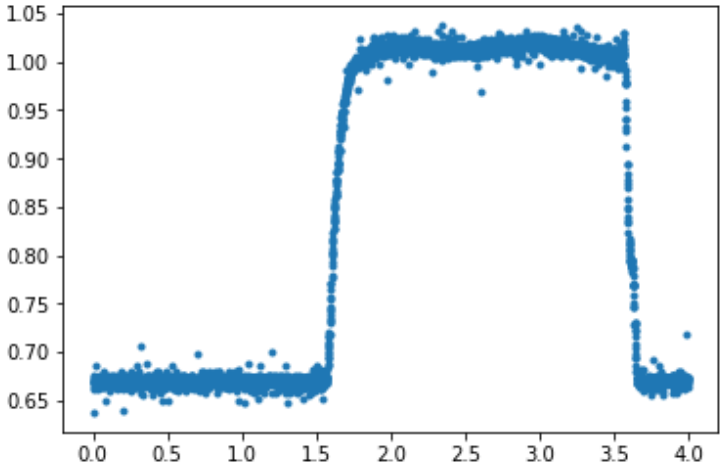
Picture credit: Artistic rendering by Zosia Rostomian, Creative Services, Lawrence Berkeley National Laboratory

Katie LaChasse

Using Machine Vision to Study Subcritical Transition to Turbulence in Taylor-Couette Flow

Advisor: Daniel Borrero-Echeverry
Funding: SCRP – Mary Stuart Rogers Foundation

Turbulence, characterized by a high degree of spatiotemporal complexity and continuously irregular fluctuations in the flow velocity of a fluid, is the preferred state for most fluid flows and widely used in many processes. However, the underlying mechanism driving the transition to turbulence is not yet understood. Also misunderstood is the subcritical transition to turbulence, which requires a finite perturbation to rapidly transition from smooth, laminar flow to turbulent flow. In my research, I automated the process of recording when an injection perturbation causes laminar flows to become turbulent in a Taylor-Couette system via image processing and computer programming. Using an industrial USB camera, I was able to capture and distinguish when and for how long the fluid was turbulent and therefore reduced the tedious need for human oversight and manually recording data. Furthermore, I was able to create and repeat a "boxcar" pressure trace for each perturbation, thus making each trial much more comparable. A high number of trials are needed as the transition to turbulence is probabilistic, so this automated method provides much more reliable data to analyze than past studies.



Marcella Murillo

No Sugarcoating, Oral Hypoglycemic Drugs Correlate to Higher HbA1C and Proprioceptive Imbalance in Patients with T2DM

Advisor: Lucas Ettinger
Funding: SCRP

We previously identified lower extremity proprioceptive deficit in patients with type 2 diabetes mellitus (Ettinger, 2018). This current investigation explored diabetic severity on the magnitude of proprioceptive disparity. 10 diabetic subjects have participated in this study to date. To establish diabetic severity, participants completed a series of questionnaires which included current medications and dosages. Prior to proprioceptive testing, participant's blood samples were collected to measure their HbA1c (average 6.69%). For proprioceptive testing, participants performed leg extensions to randomized target positions of 15°, 30°, 45°, 60° degrees of elevation in the sagittal plane. Each target was repeated a total of four times. Subjects were guided to target positions in the absence of visual feedback via auditory cues from a custom JPS application on an iPod Touch ®. When the participant entered the target position, they memorized the location of their limb in space and subsequently attempted to re-locate this position in space. Proprioceptive errors were measured from the target positioned, target remembered, target repositioned protocol. Preliminary results indicate a high positive correlation between number of oral hyperglycemic medication and HbA1c ($r^2 = 0.72$) (Figure 1), weak positive correlations have been identified between number of medications and proprioceptive deficit, and HbA1c and proprioceptive deficits (Figure 2). Further data must be collected in order to establish statistical inferences; however, these preliminary results indicate that together, HbA1c and number of hypoglycemic medications taken together may be good predictors of proprioceptive deficit (Figure 3).

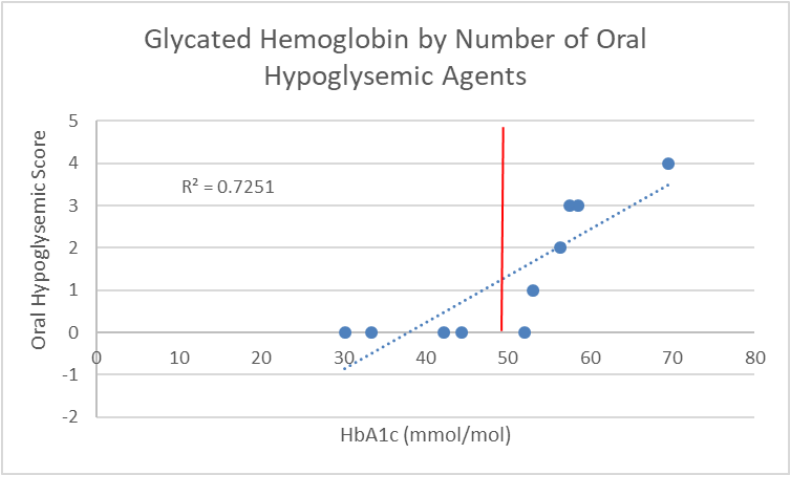


Figure 1. The number of oral hypoglycemic agents taken regressed by glycated hemoglobin in adults with type 2 diabetes. Diabetic cut-off is indicated by the red line and represents 6.5% of hemoglobin in blood is glycated. Coefficient of determination equals 0.73.

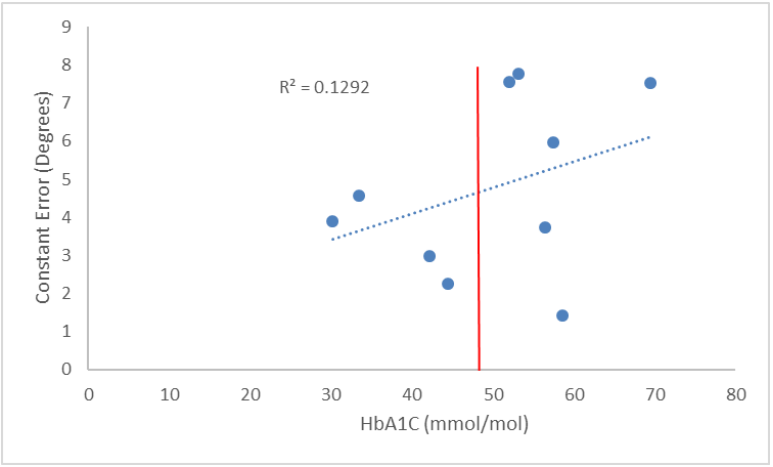


Figure 2. Proprioceptive constant error in degrees regressed by glycated hemoglobin in adults with Type 2 diabetes. Diabetic cut-off is indicated by the red line and represents 6.5% of hemoglobin in blood is glycated. Coefficient of determination equals 0.13.

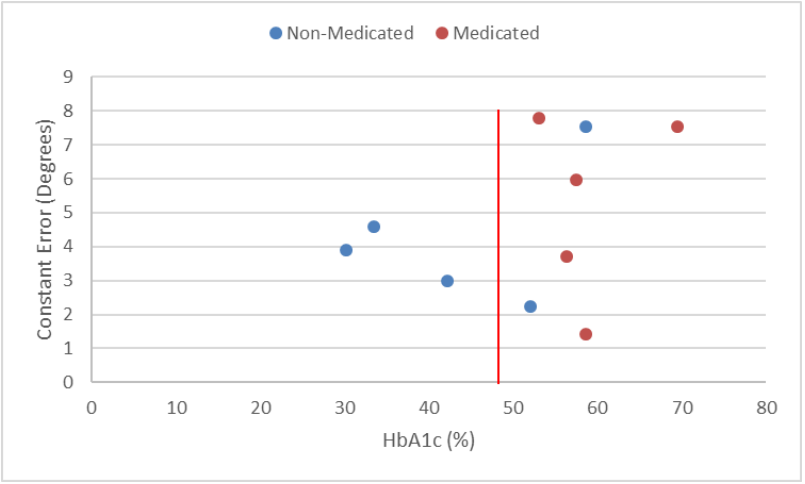


Figure 3. Proprioceptive constant errors regressed by glycated hemoglobin in adults with type 2 diabetes who are on oral hypoglycemic agents and those who are non-medicated. Diabetic cut-off is indicated by the red line and represents 6.5% of hemoglobin in blood is glycated.

Keeton Nance

Photolysis of halogenated estrogens as a practical waste water treatment process

Advisor: David Griffith
Funding: SCRP

Estrogens are moderately-potent endocrine disrupting compounds which pose a significant risk to the sexual fitness of organisms in aquatic systems where estrogens are released in waste water effluent. Estrogens are typically present in aquatic systems in their free forms, but emerging evidence suggests that their halogenated derivatives are also being released into the environment as a result of the chlorine disinfection process in waste water treatment plants (WWTP). Once in the environment, estrogens can be removed through a number of processes such as dilution, sorption, biodegradation and photolysis. While the photolysis of free estrogens such as 17β-estradiol (E2) is understood to be slow, and therefore not an important removal pathway, until now we lacked a sufficient understanding of the photolysis of halogenated estrogens such as 2,4-dibromo-17β-estradiol (diBrE2). For this reason, we studied the photolysis of diBrE2 under natural solar irradiance in four solution matrices—ultrapure water, ultrapure water with Suwanee River Humic Acid, Willamette River water, and secondary treated waste water—in order to determine the rate at which halogenated estrogens are photodegraded in both laboratory and environmentally-relevant aquatic systems. We found that in each matrix, diBrE2 degraded on minute time scales, which suggests that photolysis is a major removal pathway for halogenated estrogens. This result is of particular importance because it encourages halogenation and successive UV-based waste water treatment processes, which could be implemented in WWTPs globally in order to remove a significant amount of estrogen before they reach receiving waters.

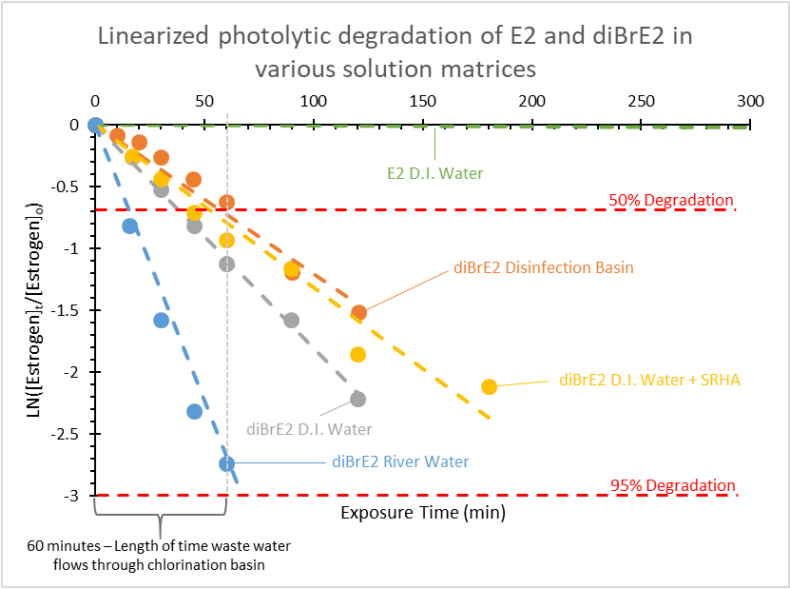


Figure 1: Linearized photolytic degradation of 17β-estradiol (E2) in ultrapure deionized (D.I.) water and 2,4-dibromo-17β-estradiol (diBrE2) in various solution matrices—D.I. water, D.I. water with 5 mg/L Suwanee River Humic Acid (SRHA), Willamette River water, and secondary treated waste water effluent (Disinfection Basin). Regardless of matrix, diBrE2 degrades by at least 50 percent within an hour, which is the amount of time waste water spends in the chlorination basin, whereas E2 doesn't reach 50 percent degradation for 8 days. The data suggest that significant amounts of estrogen can be removed from waste water via halogenation and successive photolysis before the effluent reaches receiving waters.

Dayton Towata

The role of WASP binding to the arp2/3 complex in actin assembly in cells

Advisor: Brad Nolen, University of Oregon
Funding: National Science Foundation (NSF)

Arp2/3 complex is an actin regulator that nucleates branched actin filaments essential for cell motility, endocytosis, and exocytosis. In *Saccharomyces cerevisiae* these branched actin filaments are critical for engulfing and transporting extracellular substances. To nucleate new actin filaments, Arp2/3 complex must be activated by a nucleation-promoting factor (NPF). Recent data identified two binding sites on Arp2/3 complex for Las17, the dominant NPF at yeast endocytic sites. How engagement of Las17 at each of these two sites contributes to assembly of actin networks at endocytic sites is unknown. To address this question, we used the available structural information to design ~20 mutations in three of the seven subunits of the complex, as shown in figure 1 below, that could influence Las17 interactions at either binding site. We created *S. cerevisiae* strains in which the mutant Arp2/3 complex subunits replaced the wild type copy and monitored the assembly of endocytic patch assembly in live cells using GFP-tagged Abp1, a protein that binds to actin filaments in endocytic actin patches. We found that despite the ~20 mutations causing varying effects in binding affinity and activity in vitro, there were slight alterations in the endocytic activity of the mutated strains. Looking at the Las17 and Arp2/3 binding interaction of *Saccharomyces cerevisiae* will further our understanding of Arp2/3 complex regulation. This has important implications for human health, because Arp2/3 complex is conserved in higher eukaryotes and plays a role in the migration of metastatic cancer cells.

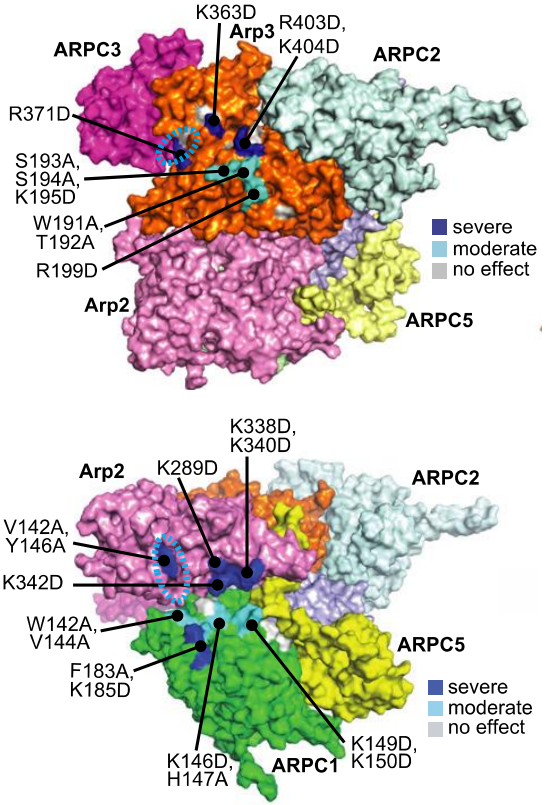


Figure 1. Mutations in the Arp 2, Arp 3, and ARPC1 complexes that are used to show the importance of the specific NPF binding site in actin assembly in cells.

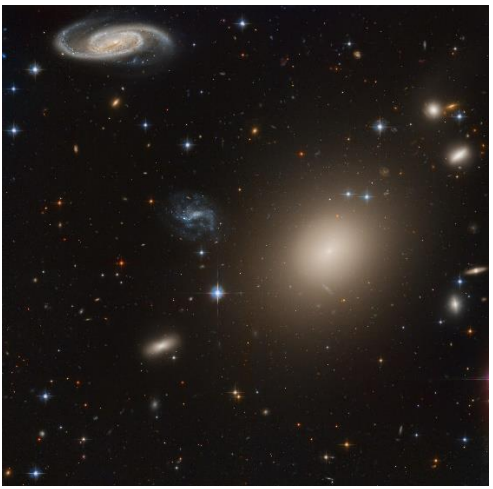
Annie Wang

Investigating the Large-Scale Structure of the Universe by Calculating the Density Autocorrelation Function

Advisor: Richard Watkins

Funding: Murdock Charitable Trust College Research Program for the Life Sciences

The existence of the baryon acoustic oscillation (BAO) is well measured by scientists through the two-degree Field Galaxy Redshift Survey (2dFGRS) and the Sloan Digital Sky Survey (SDSS). Brent Tully constructed the density field in a cube with sides of 400 Mpc from the 2MASS redshift catalog. This density field allows us to calculate a much more accurate density correlation function than previous work using galaxy counts. Previous studies have found the BAO while analyzing the data at very large scales; however, we have been able to detect the BAO using data of a much smaller scale. The BAO is a density fluctuation of baryonic matter and shows up as a feature, specifically a bump, in the correlation function. Therefore we constructed a two-point correlation function within a ball of radius 215 h^{-1} Mpc. It provides a good fit with the known results. We see a decreasing slope with a BAO bump at around 110 h^{-1} Mpc. We also calculated the fourier transform of the correlation function, which gives us the power spectrum. The shape of the resulting graph is promising but the normalization is poor. In all, our research has successfully found the BAO analyzing at a much smaller scale.



https://apod.nasa.gov/apod/ap180525.html

Angus Williams

Ionic Impurity Effects in the Isobutyric Acid + Water Liquid-Liquid System

Advisor: J. Charles Williamson
Funding: Foot SCRP Fund

Liquid-liquid systems are the basis of many separation and purification processes prevalent in industry, making the behavior of liquid-liquid systems of interest under different conditions such as contamination. Third component impurities miscible with one component have been shown to decrease overall miscibility while those miscible with both increase miscibility. The isobutyric acid + water (IBA+W) system has been studied extensively due to its insensitivity to water impurities and its easily accessible critical temperature near 27°C. Past investigations of ionic impurities in the IBA+W system show both the critical composition in terms of IBA (X_c) and the critical temperature (T_c) shifting to higher values. In past experiments we have observed the degradation of the IBA+W system and found droplets beginning to form 0.1K-0.5K above the coexistence temperature (T_{cx}) on the H_2O rich side of the coexistence curve only. This has been named pre-transition droplet formation (PTDF) and is a new phenomenon. A third component impurity from the degradation could have caused PTDF. In this study a consistent 0.3 *m* KCl impurity was introduced to IBA+W samples whose compositions spanned the system's critical composition. T_{cx} was determined using a multiple angle laser light scattering technique. From the data the critical point was determined. The impurity caused the critical point to migrate towards lower composition (in terms of isobutyric acid) and to higher temperature, contrary to past findings. Previous studies may have been misassigning the critical point at the maximum T_{cx} value, an interpretation that is valid only for pure binary systems. Our data shows that an added impurity does not simply translate the coexistence curve; each T_{cx} value is shifted differently. It was also found that a proposed universal linear relation between reduced critical temperature and reduced critical composition may hold true for the isobutyric acid + water system.

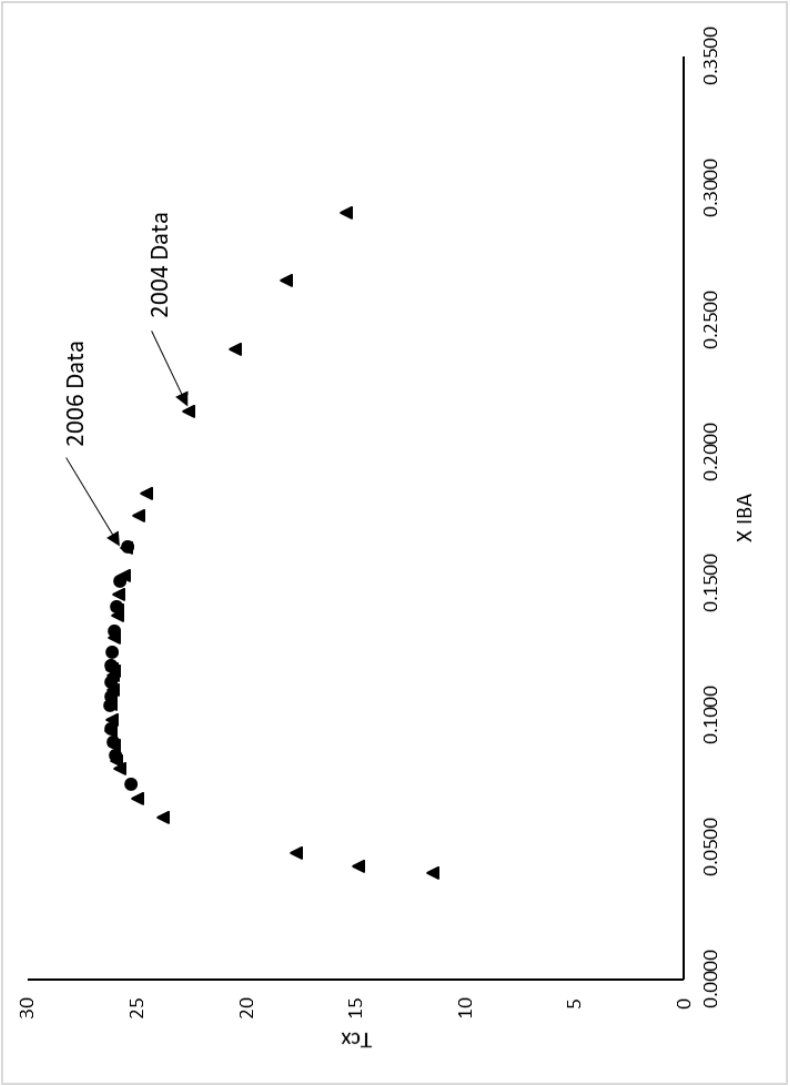


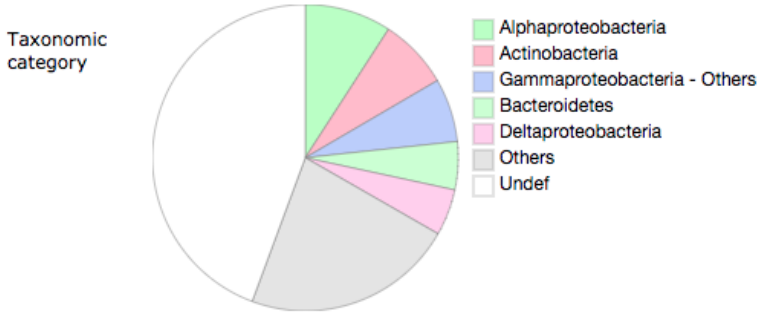
Figure 1: A plot of coexistence temperature T_{cx} as a function of Isobutyric Acid mole fraction for the IBA+W system. Previous studies have assigned the critical point at the maximum observed T_{cx} value, but our methods show that the critical point is located at a lower temperature.

Brett Youtsey

Metagenomic Analysis of Secondary Metabolites in Marine Sponges

Advisor: Rosa León-Zayas
Funding: SCRP

Secondary metabolites represent limitless potential for drug discovery. In response to the growing demand for novel drugs, biologists are searching microbially diverse microenvironments as possible hotspots of secondary metabolites. The Leon-Zayas Lab has performed metagenomic analysis of DNA extracted from marine sponges and surrounding sediment samples from the Fiji Islands. With sophisticated bioinformatics techniques, we aim to distinguish marine sponges as a promising source of secondary metabolite rich microbial communities. Through de novo assembly, we have created dozens of draft genomes without the aid of a reference genome. Taxonomic predictions of sample populations were made by comparing draft genomes to online databases. Bioinformatic tools were also employed to search for gene clusters homologous to those known for secondary metabolite production. The initial results suggest marine sponges possess a majority of secondary metabolite genes within the microbial community that are phylogenetically distinct from sediment sample communities.



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