President's Summer Research Symposium

FRIDAY, OCTOBER 21, 2016

With support from the
Office of the Dean for Academic Affairs

Bowdoin

Order of Events

12:30 p.m.–1:30 p.m.
Kresge Auditorium, Visual Arts Center

Welcome
Jennifer Scanlon
Interim Dean for Academic Affairs

Keynote Lecture
The Challenges of Creating Software with Machine Learning
Peter Norvig
Director of Research at Google Inc.

1:45 p.m.–3:30 p.m.
Morrell Gymnasium

Address
Clayton S. Rose
President of the College

Student Poster Presentations

The Challenges of Creating Software with Machine Learning

PETER NORVIG

Software is usually built by programmers, who consider all possible situations and write rules to deal with them. But many applications are now created by machine learning, and the programmer is replaced by a trainer who shows the computer examples until it learns to complete the task. This shift in how software is built opens up new possibilities and poses new challenges.

Peter Norvig is a director of research at Google Inc. Previously, he was head of Google's core search algorithms group and of NASA Ames's Computational Sciences Division, and he received the NASA Exceptional Achievement Award in 2001. As co-teacher of an artifical intelligence class that signed up 160,000 students, he helped kick off the phenomenon of massive open online classes. His publications include the leading textbook in the field of artificial intelligence, *Artificial Intelligence: A Modern Approach*, and he is the author of the world's longest palindromic sentence.

Visual Ball Detection, Locomotion, Behaviors, and Audio Signal Processing for Bowdoin's "Northern Bites" RoboCup SPL Team

CORY ALINI '18, MARCUS CHRISTIANSEN '17, PHIL KOCH '15, JAMES LITTLE '19, MEGAN MAHER '16, NIKKI MORIN '16, KONSTANTINE MUSHEGIAN '17, AND ISABELLA TUMANENG '17

Mentors: Eric Chown and Bill Silver

RoboCup is an international robotics research competition featuring autonomous robots engaged in endeavors such as soccer matches, rescue missions, and household chores. The Northern Bites compete in the Standard Platform League (SPL), a robotic soccer competition in which all teams program identical robots. The SPL rules change annually to further advance toward the goal of challenging human soccer players by 2050. This summer, we tackled new problems such as detecting realistic soccer balls, integrating a new motion engine, processing audio signals, designing more efficient behaviors, and further developing a Drop-In player to compete in games of "pick-up" soccer. Our results are best summarized by our performance: we placed ninth in the Drop-In Challenge and overall within the top twelve SPL teams in the world.

Predicting Sorption of Anionic Compounds to Soils: An Evaluation of Probe Compounds

LEAH ALPER '17

Mentor: Dharni Vasudevan

Detectable concentrations of pharmaceuticals and other chemicals have been measured in natural waters, soils, and sediments. Our research focuses on the development of a predictive model for the sorption, the transfer of chemicals from water to soil, of negatively charged (anionic) pharmaceuticals. Sulfasalazine (used to treat ulcerative colitis) sorption was measured onto thirty soils and compared with sorption of other previously examined anionic pharmaceuticals and measureable soil properties. We established that sulfasalazine sorbs to soils primarily via surface complexation mechanism and that its sorption could not be predicted by traditional soil properties. Instead, sorption was well correlated to the sorption of a probe compound, salicylic acid. This supported a probe-based conceptual mathematical model for more effectively predicting chemical transfer from water to soil.

Physiological Implications of Sexually Dimorphic Auditory Interneuron Recovery in *Gryllus bimaculatus*

MICHAEL AMANO '17 AND REBECCA FISHER '17

Mentors: Hadley Horch and Patsy Dickinson

While adult nervous systems typically respond poorly to injury and deafferentation, the cricket *Gryllus bimaculatus* presents an interesting example of compensatory growth following auditory deafferentation. Unilateral ear loss in the adult cricket prompts auditory interneurons (AN-1 and AN-2) in the central nervous system to sprout compensatorily and form synapses with the contralateral auditory nerve (N5) via dendritic extension across the midline of the prothoracic ganglion. Additionally, this growth response is sexually dimorphic, where females undergo rapid dendritic growth that plateaus at three days post-deafferentation while males undergo linear dendritic growth that can reach lengths double those observed in females. Despite characterization morphologically, it is unclear how this translates functionally. This study seeks to determine if this sexual dimorphism is present in physiological responses of AN-2.

Does Vasotocin Produce a Context-Dependent Effect in *Carassius auratus*: Testing Its Effects on Male Courtship

CHRISTINE ANDERSEN '16

Mentor: Richmond Thompson

The nonapeptide arginine vasotocin (VT) has previously been shown to have different effects on courtship, aggression, and social interactions with conspecifics in different species of fish. A VT receptor antibody used to map VT receptor fields revealed expression in the dorsal telencephalon and hindbrain. Later, we will test whether previously seen species-dependent differences may instead depend on the social context under which animals were tested (ie. pheromone exposure). Previously, VT injections in males inhibited approach responses toward conspecifics. I will test if VT injections in males increase approach toward females in a courtship context. If this is the case, the mechanism by which this switch occurs will be tested by comparing and quantifying different VT membrane receptor complexes in female pre-ovulatory, pheromone-exposed fish with control fish.

Simulating the Evolution of Oscillons after Inflation

SOPHIA ARDELL '17 AND HENRY DANIELS-KOCH '17

Mentor: Thomas Baumgarte

After the Big Bang, there was period of rapid expansion in our universe known as inflation. The energy during and after inflation can be modeled spatially and temporally as a fabric of scalar field matter. As a result of inflation's immense potential energy, small and random perturbations in the scalar field grew into larger "blobs" of matter known as oscillons. Oscillons are hypothesized to have driven the first formation of large-scale structure in the universe and may have led to the creation of primordial black holes. We emulate Amin's computational simulation of a scalar field in one dimension over time to confirm the emergence of oscillons. To improve the code's runtime, we implement a variety of optimization techniques such as parallelization with OpenMP.

Factors Influencing Anisotropic Stretch of the Beating Heart of *Homerus americanus*, American Lobster

ABDUL-LATIF ARMIYAW '18

Mentors: Amy Johnson and Olaf Ellers

When a lobster's heart contracts, the alary ligaments and arteries attached to it store energy, which enables the contracted heart to stretch to its relaxed state. We investigated the relationship between stretch of the heart and stretch of its ligaments and arteries by using Tracker video analysis software to quantify relative length changes (strains) of each of these structures; for the whole heart, length changes were quantified along both the longitudinal and transverse axes of the heart. We concluded that the strain of the whole heart was 50 percent greater along the shortest portion of the transverse axis than it was along the longitudinal axis. Future research will involve mechanical tests of individual ligaments and arteries to quantify their contribution to the relaxation/stretch of the heart.

15 Villainous Fools

OLIVIA ATWOOD '17

Mentor: Davis Robinson

This summer, Maggie Seymour '16 and I took our two-woman show, *15 Villainous Fools,* on the road. We travelled to five different Fringe Festivals across the country. We met artists who inspired us, performed in venues we had seen for the first time mere hours before, and were reviewed by professionals. We learned how to perform when you're hungry, tired, or late to your own show due to flash flood rain, a car crash, and unprecedented amounts of traffic. No matter what happens, you get on that stage, lift your face to the lights, and perform. In numbers: 5 cities; 5,768 flight miles; 120 plus hours road tripping; 3 sets of show clothes; 50 props and costumes; 20 shows; 15 characters; 2 sweaty, tired, smiling actresses; and 1 amazing summer.

Fellowship with the Maine Coastal Program

ETHAN BARKALOW '18

Mentors: Matthew Nixon, Maine Coastal Program; and Claire Enterline, MCMI

At the Maine Coastal Program (MCP), I completed much of the preparation work for a monitoring project that will commence next spring. The MCP owns ten Rod Surface Elevation Tables (RSETs), which measure sediment erosion and accretion in salt marshes and are used for monitoring purposes. I researched scholarship pertaining to salt marsh science, and I looked into RSET monitoring protocol. This research allowed me to propose potential site locations in salt marshes along Maine's coast and draft a grant proposal to request funding for RSET installation equipment. In addition to my office duties, I was a marine mammal and avian observer for the MCP's survey vessel, which gathers data on the bathymetry of Maine's coast.

Computational Inference of Bacterial Horizontal Regulatory Transfer in HemH, a Core Gene of *E. coli*

RYAN BARRETT '17

Mentors: Clare Bates Congdon; Craig Lessard, Maine Medical Research Institute

In this project, we assessed the degree of conservation between the regulatory regions of the HemH gene in several strains of *E. coli* using a computational tool developed in the Congdon lab. HemH is of particular interest because it is a core gene. HemH was also studied in a 2014 PNAS paper, which examined the conservation via multiple alignment of this region and concluded that there were stretches of unconserved regions. The approach used in the Congdon lab accounts for sequence shuffling and found that the best-conserved DNA segments were evenly distributed across the upstream region. The Congdon lab's computational tool provides a more comprehensive approach than multiple sequence alignment when used to assess the regulatory region of the HemH gene in *E. coli*.

Immigrant Legal Advocacy Project Summer Fellows

EVAN BAUGHMAN '17 AND ISAAC MERSON '17

Mentor: Christina Starr, Immigrant Legal Advocacy Project

Our primary project for the summer was to manage Immigrant Legal Advocacy Project's Temporary Protected Status (TPS) renewal cases for clients from Honduras and El Salvador. We also assisted clients seeking immigration benefits, such as permanent residence and citizenship, and helped during intake appointments by screening clients for eligibility. Our specific duties included reaching out to clients for scheduling and assisting clients in filling out immigration forms, as well as writing cover letters and affidavits explaining more complicated aspects of their immigration history.

Save the Children–International School Health and Nutrition

MEGHAN BELLEROSE '17

Mentors: Sarah Bramley, Save the Children US; Nancy Riley

I spent my summer at Save the Children in Washington, DC, working on the International School Health and Nutrition team. My primary projects were to produce country reports and total reach statistics for the 2015 SHN Program Update, a document shared with donors and NGO partners to highlight existing program areas and to communicate with in-country staff to collect and summarize health education strategies from forty-three countries. I also began an independent research project investigating the strengths and weaknesses of school-based programs focused on the health of adolescent girls by interviewing INGO staff. In addition, I had the opportunity to learn about global maternal and child health by attending conferences hosted by a variety of nonprofit and UN organizations.

Impact of a Farm-Based, Family-Focused Model for Nutrition Education and Diabetes Prevention

JULIA BERKMAN-HILL '17

Mentor: Ingrid Nelson

I studied the impact a children's gardening and cooking program on an urban farm in Connecticut had on the children's families. Through various qualitative research methods, I completed a preliminary evaluation. I developed an impact pathway to identify the program's desired outcomes and conducted a literature review on the effect of children's nutrition education on the family's behavior. Based on the literature and individual interviews with several children, I created and piloted a survey for children ages six and over. My work will help the program develop a curriculum with clearly defined goals. I will continue my research in nutrition by looking at the historical and political context in which programs are developing that allow doctors to prescribe local produce as an alternative to medication.

Preparations and Electrostatic Modeling of a Short-Range Test of the Inverse-Square Law of Gravitation with a Superconducting Torsion Balance

PATRICK BLACKSTONE '17

Mentors: Clive C. Speake and Chris J. Collins, School of Physics and Astronomy, University of Birmingham, UK

A question of increasing interest in gravitational physics examines the validity of the inverse square law (ISL) of gravity on small scales. Some theoretical models, such as the fat graviton and string theory, predict that the effect of the fundamental force at sufficiently small range would deviate from the Newtonian prediction. We aim to measure the force of gravity on a scale of approximately 15 microns using a novel superconducting torsion balance. This NSF-funded, University of Florida-arranged, and University of Birmingham-hosted project focused on aligning the polarization maintaining fiber for use in the ILIAD interferometric system. In addition, numerical models were created using Finite Element Modeling Methods (FEMM) to predict the capacitance between the source and test mass, a necessary step in the practice of the micropositioning system.

Stratigraphic Investigation of Possible Dorset-Thule Interaction at Iita, NW Greenland

LARA BLUHM '17

Mentor: Genevieve LeMoine

The archaeological site of Iita in northwest Greenland has witnessed numerous phases of occupation, from the Dorset (c. 700 BCE-1300 CE), to Thule (c. 1300 CE), to both Thule and Western explorers (early 1900s). One of the major questions of Arctic archaeology is whether or not the Dorset and Thule had contact with each other; if they did, Iita is a strong contender to have been a site of such interaction. Iita's geography makes it uniquely well suited to archaeological investigation, since colluvial deposition on top of an alluvial fan has generated much greater sediment depth (>1m) than is possible in most of northern Greenland. This 2016 field season has focused on deriving a more specific understanding of the site's vertical stratigraphy and the Dorset-Thule question.

Egg Recognition of Herring Gulls

ANDREW BLUNT '19

Mentor: Don Dearborn

In the face of urban ecology, the American herring gull fares incredibly well. With its nesting surroundings often offering potential dangers for nestling and adult health, such as garbage and its abundance of pathogens, nest sanitation becomes an important aspect of life come breeding season. And without the pressure from brood parasites for birds to learn what their own eggs look like, do they? There are many possible variables that could lead to this decision among the birds, but this study on Kent Island in the Bay of Fundy focused on three binary variables: size, shape, and color, all of which proved to have an impact on these decisions. The rejection rates of added items were under 50 percent for most, a safe decision for birds who cannot truly tell the difference.

Association Between the Local Food and Physical Activity Environment, Health Behaviors, and Cardiovascular Disease Risk in Maine Counties

ALLISON BRIGGS '17

Mentor: Kathleen Fairfield, Center for Outcomes Research and Evaluation, Maine Medical Center Research Institute

Adverse lifestyle behaviors are the primary contributors to mortality and morbidity in the United States and the world, especially with regard to cardiovascular health (CVH). We identified individual and environmental factors associated with adverse lifestyle behaviors and CVH indicators in Maine counties using Behavioral Risk Factor Surveillance System and USDA data. Prevalence tables and multivariate logistic models described contributions of demographic and environment variables to CVH variation. We found that demographic factors were significant drivers of CVH outcomes. After adjusting for demographics, the strongest environmental predictors of obesity and poor CVH were low median income, low density of full-service restaurants, high density of convenience stores, and low density of fitness facilities. These findings highlight the impact of local environments and contexts on Maine CVH outcomes.

Using the RDoC Matrix as a Framework for Advancing the Understanding of Suicidal Behavior

HANNAH BROOS '17

Mentors: Matthew Nock and Heather Pixley, Harvard University

The National Institute of Mental Health (NIMH) recently developed a new method of classifying psychopathology called the Research Domain Criteria (RDoC), a matrix based on dimensions of observable behavior and neurobiological measures. Suicide deaths are the tenth leading cause of death worldwide, yet not much is known about the risk factors for suicidal behavior. We utilized the RDoC framework to address the gaps in our current understanding of suicidality and self-harm by conducting a comprehensive literature review of all constructs with suicidal outcomes. We aimed to examine, translate, and organize virtually all relevant research in order to produce a comprehensive database and data visualization tool to examine suicide risk within the RDoC framework.

The Associations among Personality, Social Media Usage, and Well-Being in College Students

SOPHIE BRUNT '17

Mentor: Sam Putnam

Previous research has yielded conflicting results as to the effects of social media usage on well-being. Individual differences in personality are thought to influence how people use social media as well as the effects this usage has on their well-being. The current study examined the effect of personality on different types of social media usage, including passive, interactive, and self-presentation behaviors, as well as how this usage affected well-being. Results suggested that personality was the biggest predictor of well-being, but low amounts of self-presentation behavior predicted depression over and above the effect of personality. This effect occurred most strongly for those low in openness to experience.

Valuing the Alewife Fishery on the Passagassawakeag River

MICHAEL BUTLER '17

Mentor: Guillermo Herrera

Using a benefit cost model, I estimated the yearly profit the town of Belfast would receive for removing the Homes Mill Dam and reintroducing the alewife fishery on the Passawassagakeag River. On average, the yearly profit equals $42,000. Town revenue stems from the revitalized alewife harvest, the bait savings lobstermen accrue from buying alewives, and the "tax" the town receives per harvest. Costs account for up-front cost of removing the dam, and loss of hydropower revenue. In order to predict revenue from harvest, the model uses lake area and Maine Department of Marine Resource alewife management protocols to estimate harvestable alewife carrying capacity. Policy planners can use the model to evaluate other dams that could be removed for the reintroduction of an alewives.

Bio-Optical Detection of Phytoplankton in Harpswell Sound, Maine

LUKE CARBERRY '18

Mentor: Collin Roesler

NASA satellite sensors of ocean color use algorithms based on reflectance (the proportion of upwelling radiance to downward irradiance) to measure the concentration of chlorophyll in the ocean surface. To calibrate ocean color algorithms to coastal waters, which are high in color-dissolved organic matter (CDOM), hourly reflectance and chlorophyll were processed using the LOBO buoy station in Harpswell Sound, Maine, and supplemented with weekly in situ measurements of reflectance and chlorophyll concentration. The Gregg and Carder spectral solar irradiance model was replicated and used to interpolate the LOBO downward irradiance at seven wavelengths across the full spectrum to calculate hourly reflectance. A three-month timeseries of LOBO chlorophyll fluorescence, chlorophyll calculated using the NASA OC4 algorithm, and in situ chlorophyll was created.

Exploring the Effect of Messenger RNA Levels on Protein Location in the Pathogenic Yeast *Candida albicans*

ALLISON CARROLL '18

Mentor: Anne McBride

Candida albicans is an opportunistic pathogen that lives commensally in a majority of humans; however, in immunocompromised patients bloodstream *Candida* infection has mortality rates of up to fifty percent. The ability to switch between budding yeast and elongated hyphal cell forms facilitates *Candida* virulence. Localization of messenger RNA (mRNA) to the site of protein function is one mechanism hypothesized to contribute to the asymmetric protein distribution involved in hyphal growth and function. Recent work suggests the RNA-binding protein Slr1 might be involved in a protein complex that transports mRNA involved in hyphal development. This summer I have tested this hypothesis by tagging Slr1 and two additional proteins to determine whether their location changes between *Candida* cells with normal or heightened levels of a transported mRNA.

Identifying Building Footprints in Aerial LiDAR Data for Coastal Maine

GARRETT CARVER '17

Mentors: Laura Toma and Eileen Johnson

Light detection and ranging (LiDAR) is a technique used to gather highly accurate surface elevation data over large areas. Aerial LiDAR is collected from planes equipped with instruments that emit light and detect the amount of time taken for reflections to return to their sensors. Our task was to form a method to automatically detect building footprints from aerial LiDAR of coastal Maine collected through 2010 and 2011, with the ultimate goal of identifying structures that will flood in the event of a water level rise. A method utilizing Martin Isenburg's LAStools software package was developed that achieved a high level of accuracy in building identification with minor occurrences of false positives that can be eliminated easily in future iterations of our work.

Identity Politics in Standup Comedy

ANDREW CAWLEY '17

Mentor: Tess Chakkalakal

Standup comedy is often perceived as an escape from the horror and tension of real life. In fact, it can be an extremely valuable aspect of life as it can provide an objective social critique on current issues through its autobiographical and self-deprecating nature. In twenty-first century America, standup comedy has interacted with identity politics. In many cases standup is seen as an enemy of identity and political correctness because of jokes that target certain marginalized groups and individuals, but in fact standup can provide a form of positive assimilation. This occurs through the prioritization of the comic. When the comic takes control of a space, labels that often control American life are put aside, and identity is found and seen through other avenues.

The Effect of JZL184 on Anxiety in Mice

FELICE CHAN '17 AND KATIE CASE '17; ASSISTANT: ROBERT BROWNE '18

Mentor: Brian J. Piper

JZL184 is used as a model for medical cannabis in mice and has been shown to have anxiolytic properties by acting on the endocannabinoid system. C57BL6J mice were injected with JZL184, chlordiazepoxide (CDP), or saline and were given three tests. The Emergence Test and Elevated Zero-Maze (EZM) paradigms were utilized to study anxiety-like behaviors, and the marble-burying test was employed as a model of obsessive-compulsive-like tendencies. CDP and JZL mice buried significantly fewer marbles (JZL184: M= 3.4; CDP: M=6.3) than mice given saline solution (M=11.9), suggesting a decrease in obsessive-compulsiveness. Both CDP and JZL showed an increase in certain anxiety-like behaviors. These findings emphasize the role of the endocannabinoid system in symptoms of OCD and anxiety.

Acute Cell Phone Exposure Increases Anxiety-Like Behaviors in C57Bl/6J Mice

TAYLOR R. CHOATE '19 AND DONALD K. DETCHOU '19

Mentor: Nancy J. Curtis

Given the ubiquitous use of cell phones, scientists are wondering whether radiofrequency electromagnetic fields affect the brain and behavior. Additionally, the World Health Organization recently concluded that low-level radiation emitted from cell phones possibly caused cancer. This study examined anxiety-like behaviors in juvenile (4-7 weeks of age) C57BL/6J mice (N=40). Cell phones were placed under the open arms of an elevated-zero maze and hidden from view of the mice, and both were turned on or off. Inter-rater reliability was excellent, with a high correlation between two coders for time in the open-areas and head dips ($r>.90$). Mice spent significantly ($p<.05$) less time in the open area when the cell phone was on. Our data indicates that acute cell phones exposure indeed increases anxiety-like behaviors in C57Bl/6J mice.

How Important is Temperature in the Population Dynamics of the Invasive European Green Crab, *Carcinus maenus*?

HUGH CIPPARONE '19

Mentor: David Carlon

The European green crab (*Carcinus maenas*) was introduced to the United States in the late twentieth century. Since they arrived in Maine, population explosions of this crab have coincided with warmer water temperatures. I analyzed temporal and spatial patterns in green crab abundance based on three years of sampling data in Harpswell Sound of the Casco Bay Region and determined that average water temperature in Harpswell Sound is not a significant predictor of green crab abundance. Rather, site-specific ecological characteristics and the initiation of the lobster season are more important factors in explaining temporal and spatial variation. These patterns suggest that bottom-up ecological forces that influence resource availability (shelter, food) are important drivers in green crab population ecology.

Vulgar Latin and the Emergence of Spanish

SIMON CLOSE '17

Mentor: Michael Nerdahl

That Latin is traditionally thought of as a dead language, i.e. one with a definitive obsolescence, tempts the assumption of a postmortem irrelevance. On the contrary, Latin lives on in many of today's tongues—and though its disappearance as a lingua franca may now be definitive, the duration of its fall is difficult to define. The study of the transformation of Vulgar Latin (a term applied usually to the spoken language, distinct from the Classical Latin of literature) into modern Romance languages illuminates the ways a language may evolve in response to incremental, cultural change. My research focuses on the impact of Christianity's rise on the emergence of Spanish, a budding new language's revitalization of an old, and the living's preservation of the importance of the dead.

Mercury and Carbon Storage and Transport across the Upland-Wetland Interface

MARGARET CONLEY '18

Mentor: Lucas Nave, University of Michigan Biological Station

The large stock of mercury in soils is a potential source of continued contamination to watersheds despite emissions reductions. We examined the storage and transport of mercury and the linked movement of carbon in a small watershed in northern Lower Michigan, concentrating on the interface between uplands and wetlands, an area with complex flow patterns. In soils, total mercury concentrations (THg) increased with increasing carbon concentrations, and finer-textured, organic-rich horizons had the highest THg. In groundwater, THg increased with increasing dissolved organic carbon (DOC). Both C and Hg stocks were highest at lower elevations, reflecting a landscape-scale movement into low-lying, wet areas. Climate change is resulting in heavier, more episodic precipitation, which will likely enhance the transport of Hg out of soils and into watersheds.

Thionation of Peptoids for Enhanced Biomimicry

SOPHIA CONWELL '18

Mentor: Ben Gorske

Biological probes can be used to understand the mechanisms of biological systems. As proteins in the body are highly involved in signaling pathways that enable cellular communication, understanding how these proteins bind and interact inside the body is of great interest. Peptoids are an active and promising area of research because these molecules can mimic proteins to help understand cell signaling pathways. These molecules are particularly exciting because they can be easily synthesized and modified and are less susceptible to degradation in the body. Thionation of amide side chains is one strategy for influencing the electronic interactions in these molecules to create a polyproline type II helix, which is a common motif among proteins and is known to be preferentially bound by some protein-binding domains.

The Development of Mass Spectrometric Techniques for the Characterization of Neuropeptide Receptors in the American Lobster, *Homarus americanus*

CAROLINE CORBAN '17

Mentor: Beth Stemmler

Neuropeptides are short amino-acid chains in the nervous system that regulate animal physiology. These signaling molecules regulate behavior by binding with cell-membrane receptors. The neuropeptide C-type allatostatin (AST-C) causes heartbeat amplitude to either increase or decrease in the lobster, *Homarus americanus*. Differential responses to AST-C are hypothesized to be due to changes in AST-C receptor expression. Using mass spectrometry (MS), this study aims to develop techniques to detect AST-C receptors in *H. americanus*. Prior to MS analysis, these receptor proteins are extracted from brain tissues and digested into smaller fragments. We have tested various detergents to improve extraction and digestion, assessed by the detection of a sodium-potassium ATPase. Ultimately, method optimization will help characterize changes in AST-C receptor expression and its influence on cardiac response.

The Preble Street Maine Hunger Initiative

SOPHIE COWEN '18

Mentor: Michelle Lamm, Preble Street Maine Hunger Initiative

In an effort to eradicate food insecurity in Maine, the Preble Street Maine Hunger Initiative engages in outreach projects, conducts research to promote policy change, and supports food programs in schools and communities. My projects this summer included Summer Meals site support, such as nutrition education program development. I also assisted with *Hunger In Maine* survey data collection and entry and literature review research for the study and how Preble Street programs work with other Preble Street branches, such as resource center staffing and food programs support at the food pantry and soup kitchens. All projects involved community outreach and collaboration with organizations in Portland and across Cumberland County.

Hiroshima Art Exchange

VIRGINIA CROW '18 AND MICHAEL AMANO '17

Mentors: Vyjayanthi Selinger, Hiroo Aridome, and Anne Goodyear

In 1953, Japanese-American artist Chuzo Tamotzu facilitated an exchange of children's drawings between Hiroshima, Japan, and Santa Fe, New Mexico, to promote cross-cultural understanding through art. Over sixty years later, forty-two remaining Hiroshima drawings were generously lent to the Bowdoin Museum of Art, sparking this research project. In Hiroshima, Michael spoke with artists who created the drawings as children, radiation scientists, historians, and elementary schoolchildren to learn about growing up in a city devastated by a nuclear bomb. In Brunswick, Santa Fe, and Washington, DC, Virginia researched Chuzo's Tamotzu's life, the exchange, and what these drawings mean today. Our combined research will culminate in an exhibition at the Museum of Art from January 26 – April 17, 2017. We hope you visit the show!

Examining the History of Rare Ultrahigh-Pressure Rocks through Analysis of Microstructures and Compositional Variations in Kyanite by Formalizing Cathodoluminescence Data Acquisition

CAMERON DE WET '17

Mentor: Emily Peterman

Ultrahigh-pressure (UHP) metamorphic rocks form during subduction to depths greater than 100 km and are relatively rare at the Earth's surface. The mineral kyanite forms under these metamorphic conditions, and changes in its chemistry and crystallographic orientation can provide information about the deformation and exhumation history of UHP rocks. I analyzed kyanite in UHP rocks using cathodoluminescence (CL) imaging, which revealed microstructures and textures that would otherwise be invisible. I also collected compositional maps of kyanite and measured changes in crystallographic orientations within kyanite grains. A major component of this work was to formalize the process of CL imaging, which enabled us to compare data collected over multiple analytical sessions. Our findings suggest a complex multi-stage exhumation history that is uniquely preserved in kyanite.

First National Offshore Wind Farm, Block Island, Rhode Island

SHANNON DEVENEY '18

Mentors: Erik Nelson and Scott Comings, Nature Conservancy

Block Island, an island thirteen miles off the coast of Rhode Island, is the site of the first national offshore wind farm. I investigated the environmental and economic impacts of this in coordination with The Nature Conservancy. The Block Island Wind Farm (BIWF), a 30-megawatt offshore wind farm consists of five 6MW generators, a 34.5kV transmission cable to Block Island, and a second cable connecting Block Island to the mainland. The development of the BIWF is extremely controversial. With 46.2 percent of its area preserved and a tourist industry that accounts for 90 percent of its yearly income, the island illustrates conflict between natural conservation and economic advancement. While the windmills offer "clean," cheaper energy for Block Island, potential unknown future impacts pose a threat to ensuing benefits.

Modeling Multiple Plasma Populations During the June 23, 2015, Geomagnetic Storm

NICHOLAS DISTEFANO '18

Mentor: Katherine Garcia-Sage, NASA Goddard Space Flight Center

On June 23, 2015, a large geomagnetic storm resulted in the spectacular views of the aurora from places as far south as West Virginia. During this storm, spacecraft observations showed ions and electrons predominantly on open magnetic field lines. When running a global magnetohydrodynamic (MHD) model, the model suggested that the spacecraft was on closed magnetic field lines instead of open ones. Since the current model lacks a description of outflowing particles, the inclusion of this description might change the model's results. Additionally, we created a separate simulation of non-thermal particles due to Lorentz and gravitational forces to supplement the MHD model. With this simulation, we find that the outflowing particles observed by MMS come from the pre-midnight auroral region and undergo minimal acceleration.

Sweet Blood: History and Nature of Diabetes and Chronic Disease in America

WENDY DONG '18

Mentors: Matthew Klingle and Crystal Hall

Recent history and studies have shown that chronic disease is a social and historical issue, in addition to biological. Prior to the 1950s, there was limited research conducted on diabetes and minority groups such as Native Americans. However, after the 1950s, there was an explosion of research published on the epidemic of diabetes on the US Native American population. The purpose of this project is to uncover how and when research began to emerge linking diabetes to factors such as racial, ethnic, and socioeconomic differences. Using a corpus of JSTOR biomedical articles from the years 1950 to 2014, I applied methods such as topic modeling and spatial analysis in order to identify historical trends in diabetes-related articles over time and visually show changes in the distribution of research.

The Center for Grieving Children

LINDSEY DUFF '18

Mentor: Susan Giambalvo, Center for Grieving Children

The objective of this internship, completed as part of a Community Matters in Maine Fellowship, was to assess and improve the quality of the services offered by the Center for Grieving Children in Portland. Teen and tween participants in peer support programs at the Center completed a thirty-eight-item questionnaire upon entry into the programs and every six months while they participated in the groups. Paired samples t-tests revealed significant increases in participants' Resiliency ($t(44) = -4.38$, $p = .015$), Belonging ($t(44) = -3.57$, $p = .001$), and Hopefulness ($t(44) = -2.07$, $p = .044$) between the time of their arrival at the Center and the next time they took the questionnaire after participating in the Center's programs. This study was informed by experience facilitating one of the Center's peer support groups.

Grand Manan Mural Project: Science Education through Art

TRACEY FABER '16

Mentors: Donald Dearborn, Damon Gannon, Janet Gannon; Laurie Murison, Grand Manan Whale and Seabird Research Station; Mary Joan Edwards, Grand Manan Museum; and Sara Griffin, Visual Artist Grand Manan

The Grand Manan Mural Project was completed in the summer of 2016 in a collaboration between the Bowdoin Scientific Station on Kent Island and the Grand Manan Museum. The mural depicts the intertidal zone with a focus on the natural history of intertidal species and islanders' relationship with their ecosystem through local fisheries from lobster, herring, and salmon to dulsing and clamming. I worked with Bowdoin student Isaac Jaegerman and Grand Manan artist Sara Griffin to paint the first three walls, and later Mount Allison University student Shauna Gass joined the project to complete the mural, which uses painting to create an immersive educational experience of a complex ecosystem for tourists and the local community. The project was part of a broader effort to connect BSS with the Grand Manan community.

Localization and Characterization of the Modified DNA Base, 4mC, in Eukaryotes

ALIYA FEROE '17

Mentor: Eric Greer, Boston Children's Hospital / Harvard Medical School

DNA methylation is a heavily studied epigenetic modification due to its stability and transgenerational potential. One such methylation event, methylation of the N4-cytosine (4mC), has been identified in prokaryotes but only recently identified in eukaryotes by the Greer lab. To examine 4mC localization, I performed immunofluorescence on *Caenorhabditis elegans*. To begin to identify enzymes that could regulate 4mC in eukaryotes, I developed two approaches. In a hypothesis-driven approach, I cloned AlkB genes into mammalian vectors to study whether AlkB proteins could demethylate 4mC in eukaryotes. In an unbiased approach, human HeLa cell proteins were fractionated, and I tested for their 4mC demethylase activity using high-performance liquid chromatography coupled with mass spectrometry. These findings will guide future studies into the phenotypic effects of 4mC and the mechanism of gene regulation and potential transgenerational inheritance.

Predicting the Sorption of Substituted Pyridines to Aluminosilicate Clays

DANIELLE HAAS FREEMAN '17

Mentor: Dharni Vasudevan

Many emerging environmental contaminants, including pesticides and pharmaceuticals, are positively or negatively charged at environmentally relevant pHs. Sorption, the process by which contaminants are retained on or "stick" to soils, mediates the levels of these compounds found in ground and surface waters and, hence, human and ecosystem risk. However, current models cannot adequately predict the sorption of charged compounds. This research contributes to the development of a predictive sorption model for cationic (positively charged) pyridines, a substructure of pesticides and pharmaceuticals, by experimentally measuring sorption onto aluminosilicate clays, a mineral component of soils that carries negative charge. Sorption coefficients for the sorption of cationic 3- and 4-methylpyridine onto the clay sodium-illite were successfully measured. Future work will focus on using the experimentally determined sorption coefficients to predict the sorption of larger compounds.

Feasibility of Immigration in Rural Maine

THOMAS FREEMAN '17

Mentor: Carla Dickstein, Coastal Enterprises, Inc.

My research topic was the feasibility of successful immigration occurring in rural regions of Maine. In March, CEI (Coastal Enterprises, Inc.) published a report demonstrating how immigration strengthened Portland's economy. My research examined whether this economic boost could be replicated in rural areas of Maine and whether these areas possessed favorable conditions for successful immigration, both for the immigrants and for the current residents. I studied the job vacancies, available housing stock, and local demographic shifts of different towns and counties in Maine. My research found significant job vacancies at anchor employers throughout Aroostook and Washington County. These findings indicate that immigration could successfully fill holes in the labor force and stimulate economic growth in these regions.

The Art of Looking: Printmaking in New York City, 1900–1940

SARAH FRESHNOCK '17

Mentor: Dana E. Byrd

It is no accident that in New York City the medium of printmaking began to thrive at the same time that the strict social codes began to falter. From the spectacles of downtown burlesque shows to the sights of Coney Island, relaxed comportment engendered a new culture of looking, and artists capitalized on it. Printmakers employed a variety of techniques to depict the "drab, shabby, happy, sad, and human life" of a city and its people. Martin Lewis, for example, combined etching and drypoint to make the rich black tones necessary for depicting the city and its denizens at night. Innovative combinations of print techniques coupled with fresh subject matter ensured a robust early twentieth-century New York City print culture.

Population Assessment of Horseshoe Crabs during Breeding Season on Cape Cod

NICK FUNNELL '17

Mentor: Amy Johnson

Horseshoe crab populations have decreased dramatically due to human demand—one gallon of their blood can fetch up to $60,000. Cape Cod is one of the few regions with any protected horseshoe crab habitat, which allowed me to compare populations between protected and unprotected areas. I performed eighty-four snorkel transects at eighteen sites around Cape Cod between May 19 and June 19, 2016. Fully protected areas (Nauset Estuary) had the greatest abundance of crabs (2.33/transect) followed by areas with only biomedical harvest permitted (Pleasant Bay; 1.34/transect) and then unprotected areas (Cape Cod Bay, Wellfleet Harbor, and Chatham/Harwich; 0.92/transect). I plan to continue this project to quantify temporal change and to help Massachusetts policymakers revise horseshoe crab protection plans.

Intrinsic Peptidergic Modulation in the Lobster Cardiac Neuromuscular System: A Transcriptomic Analysis of Peptides and Peptide Receptors in Cardiac Ganglion and Muscle

HELEN GANDLER '17, DEVLIN SHEA '18, AND MEREDITH STANHOPE '18

Mentor: Patsy Dickinson

Central pattern generators (CPGs) can produce flexible rhythmic motor output via modulation by both intrinsically and extrinsically derived neuropeptides. The lobster cardiac neuromuscular system, which controls the beating of the heart, is a simple CPG system that has been used extensively for investigating peptidergic control of rhythmic behavior. We generated transcriptomes for the two major components: the cardiac ganglion (CG) and cardiac muscle (CM). Transcripts encoding precursor proteins for ~10 peptide families were identified from the CG transcriptome, suggesting that these peptide groups may be produced by neurons in the CG. Transcripts encoding receptors for many of the peptides identified from the CG were also identified from the CG and/or CM transcriptomes, suggesting that these peptides serve as intrinsic modulators of the cardiac neuromuscular system.

Computational Inference of *Cis*-Regulatory Modules Using Evolutionary Computation

WILL GANTT '17

Mentor: Clare Bates Congdon

Transcription factors are proteins that bind to DNA to regulate gene expression. Usually, a number of transcription factors will work together to regulate a single gene. A *cis*-regulatory module (CRM) is the set of sites on the DNA where a group of transcription factors bind. The goal of my work is to identify CRMs using evolutionary computation, an artificial intelligence problem-solving approach that is modeled after biological evolution. Identifying CRMs computationally greatly reduces the amount of benchwork required of biologists and contributes significantly to our understanding of the causes of hereditary diseases.

Reach and Subwatershed Scale Urbanization Proxies Represent Possible Links to Ecological Degradation in the Mill River

NATHAN GARNER '17

Mentors: Alan Christian, Thomas Dimino, and Sean McCanty, University of Massachusetts, Boston

Urbanized streams may be compromised due to the "urban stream syndrome" (USS) phenomenon, a concept predicting that runoff from urban impervious surfaces may change stream morphology, water chemistry, and biological integrity. The Mill River, located in Taunton, Massachusetts, is one such river that may be experiencing the USS. To investigate this phenomenon, we explored the variance in urbanization, as measured through predictor values of impervious cover, development, and habitat quality throughout the Mill River watershed. These predictor values were regressed against response values of reach scale water column physical-chemical parameters, freshwater invertebrate Streamside Biosurvey scores, and freshwater mussel species richness values using pair-wise e linear regression analyses to determine significance. We hoped to confirm our hypothesis that increased urbanization would yield lower water quality values.

Entantioselective Trifluoromethylation of Carbonyls Using Peptoid Catalysts

CHARLIE GERRITY '17

Mentor: Benjamin Gorske

The trifluromethyl moiety is useful for many different compounds, from Teflon, used as a nonstick coating, to drugs such as Efavirenz, used in the treatment of HIV. Current methods to add the trifluoromethyl group have poor substrate scope and poor solvent scope. One possible reaction to put on this group uses trimethyltrifluoromethylsilane and a nucleophilic catalyst. A chiral catalyst would provide more selectivity. One such chiral catalyst is a peptoid, a poly N-substituted glycine. Peptoids can be modified to have a large substrate scope and are known to maintain their structure in various solvents. Previous work had shown that the catalyst was prone to degradation, and this summer a modification we made to the peptoid scaffolding led to a stable catalyst.

North Pacific Barium Isotope Distributions Illustrate Importance of Ocean Mixing in Controlling Barium Distributions Despite Weak Regional Circulation

BEN GEYMAN '16

Mentors: Michele LaVigne; Tristan Horner, Woods Hole Oceanographic Institution

The dissolved behavior of barium in the ocean exhibits a nutrient-type profile similar to that of silicon, which has led to use of barium (Ba) as a proxy for carbon cycling. Marine barium cycling appears to be controlled by the near-surface precipitation of barite crystals and their subsequent dissolution at depth, which imparts an isotopic signature that harbors information about both circulation and productivity. However, the processes governing marine barium distributions remain unresolved. Here we report the first oceanographic profile of Ba-isotopes from the North Pacific (30°N, 140°W), which offers the ability to resolve biogeochemical cycling from mixing processes. Our findings highlight the utility of stable isotopes to illuminate processes governing nutrient cycling and support the critical role of large-scale circulation in setting "refractory" nutrient distributions.

Merrymeeting Food Council (Psi Epsilon ES Fellowship)

ANNIE GLENN '17

Mentors: Colleen Fuller, Lee Cataldo, and Harriet Van Vleck, Merrymeeting Food Council

The Merrymeeting Food Council is a collaboration of individuals and organizations from all aspects of the food system working together to advance our local food system. My main project was planning the logistics for an "Edible Street" in Bath, Maine, which will provide planters with edible produce in downtown Bath and at Bath Housing Authority. This project will address issues of food access and insecurity, community growth through participation and nutrition education and will spark conversations about our local food ethos. I also worked on myriad other projects that addressed different aspects of the food system. I learned so much during this experience about the nuances and complexities of food systems, and it was a privilege to work with so many dedicated individuals.

Toward Better Flood Maps for the Coast of Maine: A Computational Approach

ANGUS GORMAN '18

Mentors: Laura Toma and Eileen Sylvan Johnson

Flood Maps are topographic maps that show the extent and depth of projected flooding resulting from certain threshold "century" events–storms with a one percent annual chance of occurrence. These maps are critical in preparing communities for potential flooding risks, informing civil engineering decisions, and in determining flood insurance rates. Current maps will soon become outdated, however, as sea levels are predicted to rise up to 2 meters by 2100, drastically altering the coastline and bringing more severe flooding. This summer I created free, open-source software that allows a user to simulate flooding on a base topographic map, incorporating user-specified sea level rise and government-issued storm data.

The Effects of Myosupressin on the Stomatogastic Nervous System in *Cancer borealis* and *Cancer irroratus*

SCOUT GREGERSON '18 AND ALEXANDRA MILLER '18

Mentor: Patsy Dickinson

Central pattern generators (CPGs) are neural networks that produce patterned electrical outputs, which control rhythmic motor behaviors. CPG outputs may be modulated by molecules called neuromodulators. We tested the effects of the neuromodulator myosuppressin on the stomatogastric nervous system (STNS), a CPG that controls the muscles in the stomach and foregut, in crab species *Cancer borealis* and *Cancer irroratus*. Using extracellular recordings, we visualized the electrical activity of neurons within the STNS and monitored any modulatory response to myosuppressin. Myosuppressin had statistically significant effects on two pyloric neurons; myosuppressin application decreased the frequency of spikes within a burst for the pyloric dilator and the pyloric neurons. Thus, myosuppressin does have a modulatory effect on the STNS of these *Cancer* species, and it may be a neuropeptide of interest in future work with other crab species.

Virtual Sculpture

LAURA GRIFFEE '17

Mentor: Jackie Brown

Recent advances in gaming software and technology have opened up new possibilities for contemporary art. Through a Martha Reed Coles Fellowship, artist/professor Jackie Brown and I spent the summer developing a build-your-own sculpture application to explore the potential for Google Virtual Reality (VR)—specifically Google Cardboard—to be used in a fine arts context. The build-your-own sculpture application offers viewers a chance to be inventive and imaginative in creating their own sculptures out of parts taken from Professor Brown's work. With this application, Professor Brown and I aim to communicate core concepts of her sculptural work by offering viewers a dynamic, interactive experience that gives them creative agency and a means to explore concepts of growth and transformation.

Excited-State Intermolecular Proton Transfer in Aminonaphthols

MALCOLM GROVES '17

Mentor: Kana Takematsu

The excited-state proton affinity of amino-substituted naphthols depends on the placement and proximity of the amino and hydroxyl proton binding sites. We seek to understand the structural factors underlying proton transfer kinetics in bifunctional compounds by characterizing the excited state proton transfer kinetics of two aminonaphthol isomers with distal proton binding sites. Aminonaphthols are promoted to the excited state by the absorbance of UV light. The proton affinities of the aminonaphthol isomers 8-amino-2-naphthol and 5-amino-2-naphthol were characterized using absorption and fluorescence spectroscopy. The formation of an excited-state zwitterion was observed for both isomers. The excited state pK_a of the neutral 8-amino-2-naphthol was measured as 9.6, slightly higher than the ground state pK_a of 9.5. This strikes an interesting contrast with the strong photoacidity of 2-naphthol, a well-studied photoacid.

Kandinsky's Art through the Computational Lens

PARKER HAYES '17

Mentor: Mohammad T. Irfan

We used computational tools and techniques to analyze geometric objects, particularly straight lines and circles, in Wassily Kandinsky's paintings. Previous research by our group at Bowdoin resulted in the creation of a program that could process and extract all the straight lines from his paintings while concurrently generating data about the slopes and the lengths of the straight lines. We extended this research in two ways. First, after improving the reliability of the line detection program, we analyzed the straight-line data by producing a series of histograms displaying the statistics of line composition in Kandinsky's paintings. Second, we added the necessary components to process the circles in his paintings.

Therapeutic Targeting of Pathogenic Bacteria via Copper-Catalyzed Click Chemistry

RYAN HERMAN '17

Mentor: Danielle Dube

The efficiency of the current therapeutic approach against the gastric pathogen *Helicobacter pylori* has declined sharply due to the growth of antibiotic-resistant bacterial strains and the adverse disruption of the human microbiome. Sugar-modified protein structures, termed glycoproteins, present promising targets for therapeutic intervention due to their selective expression across bacterial and mammalian cells. This summer, we synthesized a therapeutic conjugate with the abilities to both react with chemically labeled glycoproteins via copper-catalyzed click chemistry and elicit cell death in the presence of immune effector cells. Purity of the compound was assessed via Liquid-Chromatography/Mass-Spectrometry. The ability of this product to react with *H. pylori* bacterial lysates was assessed via western blot analysis. Such analysis demonstrated that the synthesized therapeutic agent reacts with chemically labeled *H. pylori* without similarly targeting label-free controls.

Concerning Youth Grief and Loss Abroad: Jaipur, India

RYAN HERMAN '17

Mentor: Sarah Seames

I spent my summer in Jaipur, India, volunteering with Bal Basera, a center and school for homeless boys. Due to the heightened levels of street children in Jaipur as a result of gang activity, illegal child labor practices, and overall poverty, Bal Basera opened as a center for street children. The center aims to provide food and accommodation, educational facilities, and healthcare while also attempting to locate and reunite the children's families. My daily tasks consisted of instructing English, Hindi, and mathematics classes. Additional responsibilities ranged from leading yoga exercises to facilitating conversations around alcohol and drugs. Seeking to extend the center's ability to emotionally support its students in their transition home, I crafted and implemented workshops surrounding issues of grief, suffering, and loss.

At the Party

LOGAN HOUSE '17

Mentor: Mark Wethli

For my project this summer, I created figurative oil paintings of parties at and near Bowdoin that were inspired by the Paris dance hall scenes of Toulouse Lautrec and works showcasing social isolation by George Tooker. By using photographic references from College House parties and congested crowds, I focused on bringing out the subtle, yet emotionally charged elements of these settings. In capturing the elements of passing time, sexuality, anxiety, sadness, and joy, I worked to render group scenes of figures who exist together in the frame, yet engage with one another at various levels of authenticity.

The Arts of Martinique: Identity Manifestation, Conceptualization, and Representation

NAOMI JABOUIN '18

Mentors: Hanétha-Véte Congolo and Dana Byrd

In relation to my honors project, I spent the month of July in Martinique investigating the ways issues of identity are expressed through the arts. I researched at the local archive and library, visited exhibitions and art schools, and conducted interviews with Martinican artists Victor Anicet, Valerie John, Ernest Breleur, Rene Louise, and others. Each artist's path began with the desire to learn their country's own artistic history that was excluded from their academics. Whether their inspiration comes from Africa, the Amerindian heritage, or the Caribbean culture, their respective art reflects the importance they grant to history, as they believe that, "to create, produce, and dream, one must understand one's history." In my presentation, I will convey these artists' ideas, political discourse, and their influence on their country.

A Computational Search for Regulatory Regions Shared by Co-Expressed Genes

BOLOR-ERDENE JAGDAGDORJ '19

Mentor: Clare Bates Congdon

Collaborators: Craig Lessard, Leif Oxburgh, Maine Medical Center Research Institute; and Porcia Manandhar, College of the Atlantic

Noncoding DNA contains important regulatory regions, such as transcription factor binding sites, that may signal genes to be expressed or silenced. The Congdon Lab works to develop computational tools to help locate these regulatory regions. My project goal was to develop a computational tool to help identify regulatory elements that might be shared by genes that are co-expressed (active or inactive at the same time) and to apply this to a study of genes involved in the development of mesangial cells in the kidney. In my work, two candidate transcription factor binding sites were found in common among a seven mesangial-development genes. Further investigation is needed to better understand these potential regulatory elements.

Fellowship with the Kennebec Estuary Land Trust (KELT)

BENJAMIN JURCIC '17

Mentor: Ruth Indrick, Kennebec Estuary Land Trust

At KELT, I assisted on several ongoing projects and took the lead on initiating a new one. The first project I assisted with was a Bowdoin student's research for an honors thesis on mud flat geology. On the flats, I helped collect pH and temperature measurements as well as sediment samples. The second project I assisted with was volunteer-based water quality testing in Georgetown and Phippsburg. This involved collecting data with volunteers and then writing reports on what we found to disseminate to the communities. The project that I initiated this summer looked at plankton characterization in tidal waters over clam flats. I constructed several plankton sieves, wrote a protocol for collection and analysis, and analyzed the data collected during the initial testing.

Investigating the Rapid Effects of Testosterone on Olfactory Processes in *Carassius auratus*

EMMA KANE '18

Mentor: Richmond Thompson

Testosterone can rapidly affect neurons through non-genomic pathways. This suggests that testosterone may be involved in regulating social behavior, specifically in cases where social stimuli influence steroid levels. Male goldfish exposed to the female pre-ovulatory pheromone, 17α,20β-dihydroxy-4-pregnen-3-one (17, 20 BP), show increased circulating testosterone and seminal fluid (milt). We attempted to block this response by introducing ketoconazole, which inhibits steroidogenesis, and also tested if ketoconazole would non-specifically affect behavior. Fish exposed to the pheromone were injected with either ketoconazole or a control. The experiment showed that ketoconazole did not affect activity levels, suggesting that it did not cause non-specific behavioral effects. Fish treated with ketoconazole had slightly less milt; however, the results were not significant, and the blood has not yet been tested for testosterone levels.

Optimization of Linear Alpha Olefin Production through a Cationic Cobalt Catalyst with an Isocyanide Supporting Ligand

RYAN KEEFE '18

Mentor: Richard Broene

The goal of my project was to synthesize a cobalt precatalyst that, once activated, would dimerize linear alpha olefins, which have a wide range of applications in the petrochemical industry. Previous studies showed that dimerization was achieved using [Cp*P(OMe)3CoCH2CH3]+. However, whether the olefin is branched or linear depends on the geometry of the initial olefin insertion to the cobalt. Previous research showed that the ratio of linear to branched products dimerized was proportional to the cone angle, or steric bulk, of the non-Cp*supporting ligand. This summer I synthesized a cobalt catalyst incorporating a phenylisocyanide ligand in place of the trimethylphosphite, which allows the benzene ring to be further away from the cobalt atom, resulting in a smaller cone angle.

A Look into Senegal through the Talibé Experience

SAMUEL KENNEY '19

Mentors: Issa Kouyate and Rod LeRoy, Maison de la Gare; Sarah Seames

The term "talibé" refers to a particular type of Senegalese street child. Talibé children travel at a young age from different regions to coastal cities for education in the Koran. As a volunteer with the aid organization Maison de la Gare, I spent the summer learning from aid workers, activists, and educators who work to improve talibé living conditions. Although I held a daily language course in English and helped organize some group activities, my purpose as a volunteer was to facilitate greater cultural understanding. This included a constant effort to empathize and create empathy, to recognize and correct superficial or incorrect stereotypes on both sides of the Atlantic. I also worked to evaluate the effectiveness of organizations like Maison de la Gare in combatting the talibé problem.

Computational Search for Regulatory Regions for Ciliogenesis Genes

DO YEUN KIM '18

Mentors: Clare Bates Congdon and Craig Lessard

Collaborators: James A. Coffman, Mount Desert Island Biological Laboratory; Robert L. Morris, Wheaton College

The goal of this project is to computationally identify candidate regulatory regions for ciliogenesis genes and to then validate these at the bench using an urchin model. We searched for candidate cis-regulatory modules (CRMs) of ciliogenesis genes of interest–TEKT3, SRI, and IFT88–using Genetic Algorithms for Motif Inference (GAMI) created by the Congdon lab. Misexpression of these genes may result in various forms of ciliopathies in humans, including polycystic kidney disease and primary ciliary dyskinesia. We currently have two lenses through which we investigate these genes. One is focused on an exploration for potential CRMs in the human genome, while the other is focused on the identification of CRMs in the Strongylocentrotus purpuratus (purple sea urchin) genome. CRM candidates identified for S. purpuratus will be investigated at the bench.

Mitchell Institute

JOYCE KIM '18

Mentor: Sarah Seames

This summer, I worked with the Mitchell Institute (MI) to gain a comprehensive view of how a nonprofit organization operates and interacts with the community—in this case, to encourage college aspirations among students in Maine and to provide access to higher education through scholarships and extended support. I was able to participate in a variety of projects that involved programming, data analysis, and research to help the MI further the effectiveness of its resources to students. This included direct outreach and interactions with Mitchell Scholars as well as participation in the distribution and collection of various annual surveys. In addition, I planned the logistics for events centered on leadership development and college aspirations and helped update data sets to reflect the newly named cohort of Mitchell Scholars.

Pairing and Transvection in *Drosophila* Homologous Chromosomes

THOMAS KING '17

Mentor: Jack Bateman

The phenomenon of transvection occurs when a regulatory DNA sequence on one chromosome activates genes on a separate chromosome. The amount of transvection observed with the same genetic construct has been shown to vary considerably based on the position of the construct within the *Drosophila* (fruit fly) genome. In *Drosophila*, homologous chromosomes are paired in close proximity along their entire length. My project used DNA fluorescent in situ hybridization to visualize the position of chromosomes in order to investigate the relationship between the degree of pairing at particular genomic positions and the amount of transvection displayed at those positions. Although I found significant differences in the amount of pairing at different positions in the genome, these differences were not correlated with the degree of transvection.

Resilience Quantification of One-Dimensional Dynamical Systems

IAN KLASKY '17

Mentor: Mary Lou Zeeman

Resilience is currently defined as the ability of a system to undergo disturbance(s) while retaining useful characteristics. A mathematically precise definition of resilience would allow us to assess and compare quantities of resilience in a range of natural and engineered systems. In this study, we developed a method for quantifying the resilience of a single population system based on its growth dynamics. This quantification tells us if a system will undergo a state change depending on the system's growth dynamics and the range of disturbances it could experience.

A Denning Fellowship with Milestone's HOME Team

GILLIAN KRAMER '17

Mentors: Bob Fowler, Joseph McNally, Courtney Woods, and Roger Cook, Milestone

This summer I primarily worked with Milestone's HOME (Homeless Outreach and Mobile Engagement) Team to provide community support to individuals with chronic health, mental health, and substance use disorders living on the streets of Portland, Maine. The HOME Team offers intervention, referrals, and transportation for homeless individuals to Portland shelters and hospitals and to Milestone's detox program. The HOME Team also works to develop and sustain relationships with homeless individuals and acts to ensure that they are safe on a daily basis. In addition to working with the HOME Team, I created a cost-benefit analysis to estimate the monetary savings the HOME Team provides to the city of Portland. I also helped staff and clients in the emergency shelter and detoxification program to gain a better understanding of all of the services that Milestone Foundation provides.

Synthesis of a Phenylphosphabenzene Ligand for the Improvement of a Cobalt-Based α-Olefin Dimerization Catalyst

HYUNGYU LEE '19

Mentor: Rick Broene

Linear α-olefins are incorporated in many consumer products, including lubricants and sanitizers. Current industrial process utilizes oligomerization to synthesize α-olefins that are usually 4-30 carbons long. However, most marketable α-olefins are usually 8-18 carbons long. Therefore, dimerization using an organometallic catalyst could be a more efficient process. Using a cobalt catalyst with Cp*, trimethylphosphite, and ethene ligand, the dimerization of α-olefins was successful in a ratio of branched to linear α-olefins of 4.5:1. The hypothesis is that the trimethylphosphite ligand rotates freely in space, not allowing 2,1-insertion of incoming alkene, leading to branched products. Therefore, synthesis of a new ligand, phenylphosphabenzene has been proposed. Phenylphosphabenzene can π-backbond to cobalt, preventing itself to rotating freely in space, and favor 2,1-insertion to produce linear α-olefins.

The Role of Semaphorins in the Compensatory Dendritic Growth of AN-2 within *Gryllus bimaculatus*

MONIQUE LILLIS '17 AND SHANNON KNIGHT '18

Mentor: Hadley Horch

The auditory system of *Gryllus bimaculatus* is set up such that information is received by the ear, relayed by nerve-5 to Auditory-Interneuron 2, and then sent to the brain. When one ear is removed, AN-2 does not lose its function as expected, but grows across the midline of the body and forms new synapses with the contralateral Nerve-5. Previous research shows that Sema1a is downregulated by eighteen hours post-deafferentation; therefore we are interested in determining whether that change causes the midline crossing. To assess causative effects, Sema1a was knocked down in juvenile crickets using Sema1a double-stranded RNA, and dyed Nerve-5 and AN-2 were visualized using confocal microscopy. We expect that as a result of the Sema1a knockdowns, AN-2 will cross the midline of the cricket's body.

Nest Success of Common Eiders *Somateria mollissima* in Relation to Gull Density on Kent Island

ERIC LINK '17

Mentor: Don Dearborn

The common eider (*Somateria mollissima dresseri*) is often found nesting in close proximity to major nest predators such as herring gulls (*Latus argentatus*) and great black-backed gulls (*Larus marinus*). In order to determine if nesting near gulls is beneficial, ninety-six eider nests in various gull nest densities were monitored throughout the incubation period until each nest could be deemed successful or unsuccessful. Logistic regression was used to show the probability of nest success versus the number of neighboring gull nests within a 7.5 m radius. The results were statistically insignificant. Isolated eider nests were just as successful as those within dense areas of the gull colony with an overall nest success rate of 65 percent.

The Hedgehog and Retinoic Acid Cell Signaling Pathways Interact to Influence *Danio rerio* Odontogenesis

TIMOTHY LONG '17 AND CALVIN PARK '17

Mentor: William R. Jackman

The Hedgehog and Retinoic Acid cell signaling pathways are required for proper vertebrate odontogenesis. Single manipulation of either Hedgehog or Retinoic Acid signaling activity in the zebrafish (*Danio rerio*) model vertebrate during early tooth development has been shown to yield aberrant dental phenotypes. Specifically, early inhibition of Retinoic Acid or Hedgehog signaling prevents tooth formation or reduces tooth size, while exogenous Retinoic Acid induces supernumerary teeth. Here, we report that while early Hedgehog pathway overactivation does not alter zebrafish dentition, combined overactivation of Hedgehog and Retinoic Acid signaling is sufficient to return a Retinoic Acid-induced supernumerary tooth phenotype to wild type dentition. Our results suggest that Retinoic Acid signaling regulates Hedgehog activity during early odontogenesis and compensatory changes to Hedgehog signaling activity can influence vertebrate tooth development.

Assessing the Genotypic Variation in a Population of Bivalves from the Gulf of Maine

ALANA LUZZIO '17

Mentors: Sarah Kingston and David Carlon

As the waters of the Gulf of Maine change over the next 100 years, marine calcifiers will be impacted by warmer, more acidic waters. Assessing the interaction between organisms and their environment can give scientists a better idea of how populations will respond to climate change. I aim to quantify the natural genetic variation in a population of bivalves from the Gulf of Maine and associations between this genetic variation and environmental variation. The bivalve *Nucula proxima* is not significantly associated with a type of sediment but may trend towards muddy and sandy preferences. I extracted DNA from 189 *N. proxima* from 12 sites. Further work will assess variation in both genotype (next generation sequencing) and shell phenotype (scanning electron microscopy).

Linking Stress Phenotype of Blue Mussels to Standing Genetic Variation amidst a Changing Climate

PIETER MARTINO '17

Mentors: Sarah Kingston and David Carlon

Climate change will greatly impact the Gulf of Maine's biogeochemistry, causing shell calcification to become more difficult for blue mussels. We investigated the potential for standing genetic variation in blue mussel populations to rescue them from climate-induced stress using a shell-calcifying model. Mussels were collected from a natural hybrid zone spanning the Gulf of Maine and exposed to either control conditions or simulated climate change conditions. Buoyant weight was measured to quantify shell calcification over the exposure period. We found variance in shell calcification rate increases under simulated climate stress. In future studies, RNA/DNA will be extracted and sequenced in order to generate gene expression patterns under climate stress. Then the genetic architecture underlying calcification phenotypes will be investigated using genome-wide association techniques.

Studying and Writing the Lyric Poem

ALEXANDRA MAYER '17

Mentor: Anthony Walton

This summer, I studied the lyric poem in order to better understand what traditions my writing fits into and to expand my conception of what my work could become. I completed an extensive reading list that included both poetry collections and poetic theory. These readings were instrumental in guiding my work not just toward technical considerations such as form and verse, but also in helping me understand the ways one can tackle intellectual and abstract concepts in order to craft a more ambitious, more rewarding style of poetry. More concretely, my work this summer focused on the intertextuality of the marriage plot archetype—how its representations on page, on screen, and in imagination speak to one another and produce new, unintended chains of meaning.

Farm-to-Pantry Gleaning

SHANNON MCCABE '17

Mentors: Colleen Fuller, Merrymeeting Food Council, and Mary Turner, Midcoast Hunger Prevention Program

Through my work at the Merrymeeting Food Council, I established a farm-to-pantry gleaning initiative in midcoast Maine. Gleaning is the collection of food that will not be sold or harvested to make sure that it does not go into the waste stream, while feeding people in need. When there is excess food after a farmer has already harvested what he needs, gleaners pick this food and donate it to food pantries and soup kitchens so that their clients can have fresh, healthy produce. Additionally, some food might not look "perfect" — potatoes that are not perfectly round or lettuce that has grown too big — so farmers cannot sell those either. Gleaning offers a streamlined solution to two different problems: food waste and food insecurity.

Transcriptional Dynamics of *Trans*- vs. *Cis*-Acting Enhancers in *Drosophila*

GRACE C. MCKENZIE-SMITH '17

Mentor: Jack Bateman

Gene transcription requires the action of an enhancer, a DNA sequence that interacts with specific promoter elements to cause transcription of a gene. Enhancers usually act in *cis*, activating genes on the same chromosome as the enhancer. However, enhancers can also act in *trans*, activating a gene on a separate chromosome. One question about *trans*-acting enhancers is the nature of their transcriptional dynamics: whether the enhancers are randomly interacting with target sequences or doing it on a constant timescale, and how this might differ between *cis* and *trans*. To study this question, we are implementing the MS2/MCP system, which allows direct, real-time visualization of transcription. I have created reporter constructs using conventional cloning techniques and will analyze them in *Drosophila* using a confocal microscope.

Synthesis of New Hydrogen Acceptors for PCPIr-Hydrides in the Dehydrogenation of Alkanes

JOHN M. MEDINA '18

Mentors: Miles Wilklow-Marnell and William D. Jones

Alkanes, commonly used in the fuel industry, are the most abundant organic resource on Earth. However, their poor reactivity does not make alkanes as versatile in organic reactions as their respective alkene derivatives. The double bond in alkenes can be reacted in a plethora of organic reactions. Since alkenes have the ability to create new materials, ways to dehydrogenate alkanes to alkenes have been created. The problem with these dehydrogenation methods is that at the industrial scale, using heterogeneous catalysts, these reactions occur at high temperature and pressure, resulting in selectivity issues. Homogenously catalyzed methods have been developed in the laboratory setting; however, the sacrificial olefin is useless after the dehydrogenation reaction. The Jones group demonstrated that parabenzoquinones show promise as hydrogen acceptors.

Maine Boys to Men

DANIEL MEJIA '17

Mentors: Katherine Doughty and Sam Eley, Maine Boys to Men

I spent my summer working with Maine Boys to Men. My main project identified other organizations in the United States whose work also focuses on the promotion of healthy masculinity. After thorough analysis of these groups, I reported back to Maine Boys to Men as to how they can improve their Reducing Sexual Violence Program (RSVP), extend community outreach, and further collaborate with other organizations to end gender-based violence in Southern Maine. I hope to continue my study of healthy masculinity through an independent study that focuses on emotional capacity and fluency among Bowdoin males.

Community Matters in Maine: Maine Migrant Health Program

APRIL MENDEZ '18 AND JONAH WATT '18

Mentors: Lisa Tapert, Maine Migrant Health Program; Eileen Johnson and Michelle Vazquez Jacobus

Maine Migrant Health Program is a federally qualified health center that provides health care and services to Maine's migrant and seasonal farm workers. These workers come from across the United States and the rest of North and South America, with the majority coming from Haiti, Mexico, Canada, Puerto Rico, Cuba, Texas, and Florida. Throughout August, Jonah was based in Downeast Maine, where he worked at the mobile medical clinic assisting the hundreds of individuals and families who travel there each summer for the blueberry harvest. At the clinics, Jonah made patient referrals to partner organizations, conducted bilingual behavioral health screenings, and helped implement a new national mandate that federally-qualified health centers ask patients about their gender identity and sexual orientation.

Seasonal Variability of Carbonate Chemistry in Wyman Bay Mudflat: Implications for Softshell Clams

HANNAH MILLER '17

Mentor: Michèle LaVigne

Maine's softshell clam industry brings approximately $20 million to the state annually and is susceptible to reduced clam flat sediment aragonite saturation state (Ω), a predicted effect of ocean acidification. Seasonal variability of Ω, however, has yet to be quantified. For this study, overlying and surface porewater temperature, salinity, pH, and alkalinity were measured biweekly from March to August and were used to calculate Ω. Reduced freshwater flow from the spring into summer resulted in higher salinity, alkalinity, and Ω. pH values showed no seasonal trend. The strong correlation between alkalinity and salinity (R^2=0.78-0.99) suggests freshwater flow with spring melt during clam's planktonic larval stage, and rain events (predicted to increase with climate change) can reduce Ω, with potentially negative implications for clams' early life stages.

Maine Conservation Voters

EMMA MOESSWILDE '18

Mentors: Eileen Johnson; Melissa Mann, Maine Conservation Voters

During my summer working with Maine Conservation Voters, I was able to observe the ways in which nonprofit organizations can take action to protect the environment. I spent a large portion of my summer working on development of the annual Environmental Scorecard, which shows voters how their elected officials have voted on environmental issues in the past session. I also helped MCV develop their early and regular endorsement slates for the 2016 elections. In addition, I worked on community organizing and outreach for the elections as well as the national Climate Action Campaign. I was also privileged to attend the National League of Conservation Voters' annual Lobby Day in Washington, DC, where I spoke with the Maine congressional delegation about national and state environmental issues.

Naptoid Secondary Structures

EMILY MUMFORD '17

Mentor: Benjamin Gorske

Peptoids are oligomers capable of adopting novel and biosimilar secondary structures. While peptoids lack backbone chiral centers, chirality can be introduced through side chains. While inclusion of both enantiomers of a chiral side chain is often destabilizing, both enantiomers of naphthylethylamine can be incorporated in a single strand, forming a unique ω-strand pattern. In search of further novel secondary structures, peptoids containing naphthylethyl or naphthylethyl and aniline side chains were synthesized. Additionally, it was investigated whether a naphthylethylamine dimer would selectively react with one enantiomer of naphthylethylamine over the other from a racemic mix due to the structural rigidity engendered by the naphthylethyl side chain. Future directions include improving and scaling up syntheses, NMR analysis, crystal structure determination, and investigations into diastereomer resolution.

Climate Adaptation Curriculum and Training for Business Counselors

JESSE NEWTON '18

Mentors: Gray Harris and Daniel Wallace, Coastal Enterprises, Inc.

This summer I interned at Coastal Enterprises, Inc. (CEI), a mission-driven lender and investor specializing in rural economic development. CEI recently launched a pilot project to supply Maine markets with ethnic, or specialty, crops in response to increased demand for culturally appropriate and locally grown food. We designed a marketing plan for the produce, evaluated its economic potential, and conducted market research in Boston. For a separate project, we developed business counseling tools and an interactive infographic for Maine's farming community. These tools will help business advisors evaluate the practical cash flow implications of climate change as they help increase the resilience and decrease the vulnerability of farm businesses in the face of a changing climate.

Characterization of Reactions Responsible for Aging in Wood-Based Pyrolysis Oil

LAUREN NGUYEN '17

Mentor: Elizabeth Stemmler

Pyrolysis oil is a potentially renewable oil source created from biomass feedstocks that could decrease dependence on fossil fuels. However, pyrolysis oil is unstable and reacts at room temperature, causing it to become highly viscous. The specific chemical reactions responsible for this instability are poorly understood. This research attempts to better understand the chemistry responsible for the instability of pyrolysis oil to potentially stop its increased viscosity. To study the reactions, synthetic oil samples were created by mixing coniferyl alcohol, a reactive compound within pyrolysis oil, with small reactive aldehydes that are also in the oil. The synthetic products were analyzed using Liquid Chromatography/Mass Spectrometry (LC/MS). Reaction mechanisms and products were hypothesized using isotopic labeling, exact mass measurements, and elemental formulas provided by the LC/MS.

Poets of Twentieth-Century Migration

JULIE O'DONNELL '17

Mentor: Anthony E. Walton

This study of twentieth-century poets Joseph Brodsky, Gwendolyn Brooks, Sterling A. Brown, Seamus Heaney, Langston Hughes, Czeslaw Milosz, and Derek Walcott seeks to trace the creative impulse through the experience of migration and exile (from the Great Migration in America to WWII and the Iron Curtain in Europe and Post-Colonialism in Ireland and the Caribbean). Attention is given to the specific locational and temporal placements of the poet. What develops out of the ruptures of society, and what value is added to literature through the unique pressures on individual lives, that a single poem may resound for many readers? Another key element of this project is to write original poems.

EpiGBS Method in Clonal Species

MARTINIQUE OGLE '18

Mentor: Vladimir Douhovnikoff

Epigenetics refers to regulation of gene expression, or turning genes on and off. The epiGBS method looks at epigenetics of tree species via methylation, the addition of a methyl (–CH3) group to a cytosine nucleotide. Multiple methyl additions to multiple nucleotides cover the DNA with the methyl groups and prevent transcription factors from recognizing specific genes. The epiGBS method allows us to identify methylation at a nucleotide level, which allows us to then identify which specific genes are being regulated epigenetically. Our research looks at clonal tree species with identical genotypes, and we look for epigenetic explanations for why genetically identical individuals can respond differently to different microenvironments. We have received some preliminary data from collaborators and are currently analyzing these early results.

Psi Upsilon Community Matters in Maine Fellowship with the Nature Conservancy

MEREDITH OUTTERSON '17

Mentor: Timothy Paul, The Nature Conservancy

As a fellow with The Nature Conservancy in Maine, I contributed to a variety of communications and environmental policy projects. Working with TNC's Latin America team remotely, I compiled research on the financing magnitude of Water Funds in Colombia and on their potential obstacles and successes. Water Funds are an innovative mechanism to finance watershed conservation, which TNC is promoting as an effective new model. I also wrote descriptions to advertise six Maine preserves, to be added to the Chapter's online interactive map to encourage more recreational usage, and tracked what previous Bowdoin-TNC fellows are doing now, to highlight their conservation career pathways. Additionally, I orchestrated a massive organizational overhaul of the Chapter's digital photo files, crafted engaging Facebook posts, and participated in conservation fieldwork.

What Could Joshua Chamberlain See at Gettysburg?

GABRIELLA PAPPER '18

Mentor: Crystal Hall

This research uses historical evidence and computational tools to answer the question "What Could Joshua Chamberlain see at Gettysburg?" Until now, Joshua Chamberlain's line of sight and perspective during the battle at Little Round Top have not been thoroughly examined. Using digital humanities methods, we can reconstruct the historical narrative and challenge interpretations of the fateful battle. I worked with the visualization software Gephi to create a network of Chamberlain's correspondence that shows the humanistic side of Chamberlain's decision making. I used GIS, a mapping software, to examine the veracity of the maps and Chamberlain's visibility from Little Round Top on July 2, 1863. The research creates a richer narrative of Chamberlain's vision at Little Round Top by combining contemporary tools with historical evidence.

Specialty Produce: Crop Diversification for Maine Farmers to Reach New Markets

LINNEA PATTERSON '18

Mentors: Gray Harris and Daniel Wallace, Coastal Enterprises, Inc.

This summer I interned at Coastal Enterprises, Inc. (CEI), a mission-driven lender and investor specializing in rural economic development. CEI recently launched a pilot project to supply Maine markets with ethnic or specialty crops in response to increased demand for culturally appropriate and locally grown food. We designed a marketing plan for the produce, evaluated its economic potential, and conducted market research in Boston. For a separate project, we developed business counseling tools and an interactive infographic for Maine's farming community. These tools will help business advisors evaluate the practical cash flow implications of climate change as they help increase the resilience and decrease the vulnerability of farm businesses in the face of a changing climate.

Experimental Determination of the Redox Potentials of Environmentally Relevant Pollutants

MICHAEL PAUL '17

Mentor: Soren Eustis

Seemingly harmless, or slightly dangerous, chemicals that people use on an everyday basis have been appearing in our nation's waterways. Wastewater treatment plants are not currently equipped to remove these chemicals from water. Therefore they are appearing in our nation's waterways in concentrations on the order of micromolar. Most of these pollutants are highly reactive and have the potential to undergo chemical reactions in the environment. Sunlight excites these chemicals, thus causing them to have the potential to undergo redox reactions in the environment. The purpose of my experiment was to use cyclic voltammetry to formulate a database of redox potentials of commonly seen pollutants in order to increase the accuracy with which we can predict the environmental fate of these chemicals.

Optimizing the Study of Interactions Between RNA-Binding Proteins in the Pathogenic Fungus *Candida albicans*

KATE PAULSEN'17 AND TOSSAPOL PHOLCHAREE '18

Mentor: Anne McBride

Candida albicans is a pathogenic fungus found in the majority of humans and causing serious infections in immunocompromised patients. Switching between its two major cell structures, spherical yeast and filamentous hyphal forms, is crucial to *Candida* invasion of human cells. MessengerRNA transport to the hyphal tip is one factor implicated in this switch. The RNA-binding protein Slr1 localizes to the hyphal tip and may be involved in mRNA transport; one approach to determine the function of Slr1 is to purify the Slr1 complex and determine its interacting-proteins. She3, a known RNA-transport protein, may be a possible interacting-protein, but preliminary results do not indicate the presence of a detectable, stable complex using current methods. The analysis of the Slr1 complex is still ongoing.

Democracy, Social Equality, and Voter ID Laws

AIDAN PENN '17

Mentor: Kristi Olson

Chances are that you harbor intuitions about the value of democracy—but chances are that your intuitions are wrong. I here examine the suggestion that our concern for democracy follows from a prior concern for social equality. By developing a range of cases surrounding voter ID laws, I refine the criteria of social equality both at the level of interpersonal relationships and at the level of formal political procedure. My central contention is that we must substantially alter our conception of social equality for it to ground a noninstrumental justification of democracy.

Community Matters in Maine: Town of Brunswick Planning and Development

AMANDA PERKINS '18

Mentors: Anna Breinich and Jared Woolston, Town of Brunswick

The Town of Brunswick's Department of Planning and Development is responsible for guiding the growth and changes in Brunswick through planning, zoning, permitting, and other enforcement. I participated in a wide range of planning activities, such as development review, interpreting and visualizing zoning ordinances, and monitoring conservation easements. I also directed an updated parking audit of the downtown area and drafted new parking literature for the Town. Consistent with previous findings, the audit showed that parking congestion in Brunswick is a localized issue, limited to a few municipal lots and streets that are popular during specific times of the week. The Town's review of parking will continue through a Common Good Day project in the fall, surveying visitors to the downtown about their parking habits.

Excited State Proton Transfer in Aqueous Reverse Micelles

ALEXANDER POBLETE ’17

Mentor: Kana Takematsu

Proton transfer is a fundamental chemical reaction and an important step in many reactions catalyzed by enzymes. Many enzyme-active sites are located in a cavity that the substrates must enter in order to react, and this confined space can alter the rate of transfer by limiting the availability of water to solvate the diffusing proton. Reverse micelles–aqueous cores surrounded by a lipid monolayer–were used to simulate cavities. The photoacid 2-naphthol-6,8-disulfonate was inserted into the cores, and the distinct fluorescence wavelengths of the protonated and deprotonated forms allowed kinetic analysis using time-correlated single photon counting (TCSPC). Lower micellar radii were found to correlate with decreased rates of proton transfer. Additionally, the protocol for the formation of the photoacid-micelle system was refined by removing equilibrium–disrupting steps, such as mixing by sonication.

Characterization of the Mechanisms Underlying Differing Responses to the Neuropeptide AST-C by the Cardiac Ganglion of the American Lobster, ***Homarus americanus***

SOVANNARATH PONG ’17 AND PATRICK WALSH ’17

Mentor: Patsy Dickinson

Rhythmic movements are controlled by neural networks such as the cardiac ganglion (CG), which controls the rhythmic heartbeat in the lobster. Neuropeptides, including C-type allatostatin (AST-C), can modulate the CG to enable it to alter cardiac output. However, applications of AST-C to the CG elicit decreases in contraction amplitude in some individuals and increases in others. We hypothesized that differences in expression of AST-C receptors among individuals might underlie this variable response and that differences in AST-C receptor expression might in turn be regulated by the molt cycle. To study these relationships, we isolated RNA from specific lobster tissues to generate transcriptomes. We will look for patterns of expressions of relevant proteins that correlate to differential response to AST-C and to the molt cycle.

Identification of Phase Relationships and Incorporation Mechanisms of Barium in Calcite Internodes of Deep-Sea Bamboo Corals

JAMIE PTACEK '17

Mentor: Michéle LaVigne

Deep-sea bamboo corals are paleoceanographic archives of barium. Dissolved barium has a similar distribution to silicon, and previous studies suggest a [Ba/Ca]bamboo-coral proxy for nutrient dynamics at depth. However, we aren't certain if extraneous Ba-bearing phases (e.g. barite, organic matter) are also influencing [Ba/Ca]bamboo-coral variability. To identify the Ba phases incorporated in bamboo corals, we developed a cleaning experiment to remove extraneous Ba phases, analyzing treated powder samples via ICP-MS and SEM/BSE-EDS. Results indicate cleaning did not alter [Ba/Ca]bamboo-coral, and no barite was identified via SEM. Our findings reinforce suggestions that the incorporation of Ba^{2+} in proportion to [Ba]seawater drives [Ba/Ca] variability in bamboo corals. These results help inform future interpretations of the [Ba/Ca] bamboo-coral proxy in sclerochronological reconstructions of changes in intermediate/deep ocean nutrient inventories.

Computational Prediction and Characterization of MX3-enes

MICHAEL PUN '17

Mentor: Richard G. Hennig, University of Florida

Possible two-dimensional (2D) materials can be modeled accurately using the computational quantum mechanical modeling method known as Density Functional Theory. This modeling can predict the formation energy of 2D materials as well as several material properties. Here we examine possible 2D materials of the form MX3 where M represents transition metals surrounding Zr in the periodic table and X includes the three chalcogens S, Se, and Te. Twenty-three out of twenty-seven of the materials examined are found to have formation energies below 200 meV/atom ranging from 44 meV/atom to 155 meV/atom. Those materials with formation energies below 200 meV/atom are characterized in terms of magnetic moment, Bader charge, band gap, and water solubility. Both direct and indirect band gap semiconductors are found as well as metals.

The Effect of Myosuppressin and SGRN on the Stretch Feedback Pathway in the Heart of the American Lobster, *Homarus americanus*

CIRCLE QU '17 AND CATHERINE LIU '19

Mentor: Patsy Dickinson

Central pattern generators are neuronal networks that control rhythmic, repeated movements, like breathing and chewing. To produce flexible outputs, this neural network can be modulated both intrinsically and extrinsically. The cardiac ganglion of the American lobster contains a stretch-mediated feedback pathway from the cardiac muscle cells to the CG. Additionally, it can be modulated by neuropeptides, such as myosuppressin and SGRN. In this study, we examined the interaction between the stretch feedback pathway and neuropeptides. We recorded either intracellularly or extracellularly from the motor neurons while stretching the muscle surrounding and underlying the premotor neurons. Both myosuppressin and SGRN decrease the system's response to stretch. Low concentrations of SGRN only slightly decrease the system's stretch response, while high concentrations almost completely negate the stretch response.

Behavioral Effects of the Injury-Induced Compensatory Growth Response Seen in the Auditory System of the Field Cricket, Gryllus bimaculatus

ELLIE QUENZER '17 AND COLBY JONCAS '19

Mentor: Hadley Horch

The auditory interneuron AN2 in the field cricket, *Gryllus bimaculatus*, demonstrates a unique compensatory growth response following injury. AN2 is responsible for identifying high-frequency sounds that elicit a behavior called negative phonotaxis. Our research aims to understand how the compensatory growth of AN2 affects negative phonotaxis after deafferentation. Unlike previous research, we found no significant difference in turn-angle intensity of male and female crickets before or after deafferentation. We also began to characterize the guidance molecule semaphorin1a, which is suspected to play a significant role in the compensatory growth of AN2. Our work this summer involved sequencing the sema1a gene in *Gryllus bimaculatus*. Eventually, we hope to use dsRNA techniques to manipulate the levels of sema1a and observe the resulting behavioral effects.

ArtVan: Community Matters in Maine McKeen Fellowship

LILI RAMOS '18

Mentor: Jamie Silvestri and Jessica Braun, ArtVan

The majority of my time at ArtVan was spent working with youth in under-resourced neighborhoods in Biddeford, Auburn, Bath, and Brunswick. Working alongside an art therapist and a teaching artist, I was able to develop the skills necessary to co-lead art therapy programs with children and parents. The Core Neighborhood programs are all funded by grants, so I was also able to learn about and assist with the grant-writing process. I attended board meetings, recorded testimonials from parents and participants, edited grant applications, and drafted certain parts on my own.

Toward Faster Visibility Analysis on Terrains

DAVID REICHERT '18

Mentor: Laura Toma

Given a digital terrain model, a viewshed is the part of the terrain that is visible from a certain point. The total viewshed of a terrain is another terrain where the value at point (x,y) represents the size of the viewshed of (x,y). Viewsheds and total viewsheds have a variety of uses such as in city planning (determining the effect of a new building on the skyline) and archaeology (reasoning about ancient landscapes and why settlements were built in certain areas). This summer, I worked toward a new and more efficient approach to computing viewsheds and total viewsheds and started a preliminary experimental analysis to quantify the speedup with respect to earlier approaches. This work builds on previous work by Kevin Zmozynski and Danny Byrnes.

Electronic Structure Analysis of Chromium-Based Photoredox Catalysts

ELLERY ROURK '17

Mentor: Anthony Rappé, Colorado State University

A theoretical characterization was carried out of two chromium(III) complexes thought to facilitate a photo-charge transfer from a pi-complexed aromatic compound. It has been shown that certain photoexcited chromium complexes are strong enough oxidants to undergo a reduction while producing the radical cation of the associated pi-complexed compound. If this associated compound is a dienophile, a Diels-Alder cycloaddition can be facilitated by the catalytic scheme provided. Time Dependent Density Functional Theory was used to compute excited state energetics. All compounds were modeled with the APFD hybrid density functional, solvated in a continuum acetonitrile solution. The four combinations of associating compounds and chromium (III) complexes showed strong binding but no charge transfer.

Intramolecular Proton Transfer in Aminonaphthols

HOLLY RUDEL '17

Mentor: Kana Takematsu

Photoacids, molecules that significantly increase in acidity upon excitation, are ideal for mechanistic studies of proton transfer (PT), a fundamental process in many biological systems. Our research focuses on aminonaphthols, photoacids with both amino and hydroxyl functional groups. Under different pH conditions, their photochemistry can involve four possible species: the zwitterion, cation, anion, and neutral species. We have experimentally explored the ground and excited state properties and proton affinities of these different species of 3-amino-2-naphthol (3N2OH) using steady-state fluorescence and absorption spectroscopy as well as time-resolved fluorescence spectroscopy. The equilibria between these species will be discussed in relation to how it elucidates the PT mechanisms. We have also found that these properties are solvent-dependent. These results have been modelled and confirmed with computational calculations.

How Language and Culture Influence the Processing and Expression of and Recovery from Grief and Crisis

CHRISSY RUJIRAORCHAI '17

Mentors: Danielle Maheu and Matthew Wolcott, Safe Passage

Over the summer, I worked with Safe Passage's development office. The nonprofit was started by Bowdoin alumna Hanley Denning to provide a holistic education for the poorest, most at-risk students in the Guatemala City dump. At Safe Passage, my work allowed me to develop a better understanding of cross-cultural nonprofits. Through this, my summer research investigated how language and culture influences the processing, expression of, and recovery from grief and crisis, as well as how these things might impact the provision of services, regulation, and policy in working with multicultural communities. While working with Safe Passage, I focused on developing self-sustainable programs and materials for recruiting and cultivating engagement with the organization. I worked primarily on program design, analysis, strategy, and implementation.

Environmental Degradation of NSAIDs: Molecular Dynamics

DAVID RUUSKA '16

Mentor: Soren Eustis

Over 300 million tons of organic micropollutants are added to the environment every year which can be detected in rivers, lakes, and oceans on the order of ng/L-µg/L. Although individual micropollutants are not classified as harmful, their degradation products could be toxic. Flufenamic acid, a nonsteroidal anti-inflammatory drug (NSAID), begins photodegradation in the environment via and electron transfer to form a radical. A method was developed to model flufenamic acid using molecular dynamics. All relevant molecules were pre-optimized using ROCAM-B3LYP/6-311+(2d,p). Flufenamic was solvated in a set number of water molecules, and molecular dynamics were run using the GAMESS software. A vertical transition was performed on the optimized structure using the IP-EOM CCSD method. Due to the long run-time of molecular dynamics and the low convergence rate of CCSD, only preliminary data has been obtained.

Parametric Study of High Temperature Superconducting Coil Quench Protection Strategies

JOSEPH SEIBERT '17

Mentors: Mike Zarnstorff and Yuhu Zhai, Princeton Plasma Physics Laboratory

Next generation fusion devices require high magnetic fields to adequately contain burning plasmas. Use of high temperature superconducting (HTS) coils to generate these fields would lower energy operation costs and increase stability of the superconducting state compared to low temperature superconducting coils. However, use of HTS coils requires developing quench protection strategies to prevent coil damage. One technique involves the utilization of conductors mutually coupled to the HTS coil to quickly extract the current from the coil. Another technique allows conduction between HTS turns to reduce the current in the coil. This project describes a parametric study of the HTS coil and resistive-conductor setup in order to determine limiting geometrical cases in an attempt to optimize current extraction and coil protection during quench scenarios.

Investigating the Rapid Effects of Estradiol on Visual Processes in *Carassius auratus*

NICOLE SEKULA '17

Mentor: Richmond Thompson

Previous studies in the Thompson lab have found that a specific estrogen receptor, ERβ, may influence visual processing in male *Carassius auratus* (the common goldfish) in response to female visual stimuli. Follow-up experiments were conducted to determine stimuli specificity. Fish were injected with testosterone (T), T and an ERβ antagonist, or vehicle in a similar paradigm used in previous experiments, but without female visual stimuli. Retinas were subsequently removed and embedded for future FOS immunohistochemistry. A complementary experiment investigated the behavioral response of this effect, with similar treatment groups. Time spent in proximity to the side of a tank adjacent to a female stimulus was recorded before and after the stimulus was introduced. Data is currently still being collected for the experiment.

Predicting Pyridine Sorption to Aluminosilicate Clays: Influence of Solid Phase Composition and Structure

SAM SHAHEEN '18

Mentor: Dharni Vasudevan

Widespread usage of organic compounds, such as pesticides and pharmaceuticals, has led to contamination of water systems by these chemicals. One determinant in the environmental fate of these chemicals is sorption, the transfer of a chemical from water to soils. This research focused on developing a predictive, compound structure-based model for sorption. Many pharmaceuticals contain a pyridine substructure, which carries a positive charge (cationic). These compounds are attracted to soil aluminosilicate clays that carry negative charge, locally neutralized by naturally occurring cations. Sorption of pyridine by cation exchange was measured across distinct clay types to analyze the extent pyridine structure influences sorption to different clays. Sorption differences between calcium- and sodium-saturated clays were smaller than other studied compounds, possibly due to pyridine's delocalized charge.

The Study of Beta-Amino Thioamides as Peptoid Side-Chains

JACK SHARLAND '18

Mentor: Benjamin Gorske

In searching for viable biological probe designs for the study of cell signaling pathways, the Gorske lab has been investigating peptoids because of their biomimicry and unusual biostability. Specifically, the lab has been trying to design a mimic for the PPII helix in order to study the interactions between this peptide motif and the WW domain, which promotes cell division. My research focuses on thionated (sulfur containing) β-amide sidechains attached to a peptoid backbone as a mechanism by which to impose a desired conformation in the overall structure of the peptoid. The use of β- analogues may allow us to improve yields of biomimetic peptoids. These compounds have never been synthesized before, and this research provides opportunities to learn about their unique structure and chemistry.

Data Visualization for the Portland Housing Authority

EVA SIBINGA '17

Mentors: Emily Mancini-Fitch and Jay Waterman, Portland Housing Authority

My focus was in creating thoughtful, clearly intelligible data visualizations to help PHA share its story and the stories of the Portland residents it serves. I created visualizations for internal use, such as a transportation survey and maps, to help further understand community transportation resources and needs as PHA moves forward with different renovation and development efforts. My work also included visualizations for public education and/or funding proposals; I made maps detailing PHA's diverse community demographics, Portland's historic and current foreign-born populations, and a visual "sound bite" introduction to PHA's study centers. Through the course of this work I learned about public housing in Portland—from the planning, development, and building process to the day-to-day operations, challenges, and triumphs in existing developments.

Brunswick Housing Authority

JOHN SLEDGE '18

Mentors: John Hodge and Martin Szydlowski, Brunswick Housing Authority

Brunswick Housing Authority is a public housing agency that has needed to confront the challenges of easing an affordable housing crisis at a time of budget cuts and an increased regulatory burden. My work focused on learning more about the financial operation by compiling multiple financial statements, writing a request for a grant to redevelop one of their communities, and learning more about the development process by attending town planning board meetings and conducting bids for site work at a new development in Topsham. Additionally, I worked with children living at one of their communities by assisting two summer enrichment programs.

Intersections II

ELIZABETH SNOWDON '17

Mentor: Jackie Brown

Intersections II is a series of illustrations examining the role of human influence in the design of new species and the relationship between science and art. These works are made with watercolor, pen and ink, and colored pencil, and each work is 26" x 40" in size. Drawing from anatomical and botanical illustration, the series explores "hybridized" specimens. The subjects in my work are believable because their components are familiar and recognizable, but they are also whimsical and mysterious because they are hard to locate within our world. Through this series, I seek to blur boundaries within the intersection between art and science, ultimately leaving it up to the viewer to visually dissect, question, imagine, and explore what is true.

Community Matters in Maine Environmental Studies Fellowship with the Maine Coast Fishermen's Association

STEPHANIE SUN '18

Mentors: Ben Martens and Kendra Jo Mars, Maine Coast Fishermen's Association

The Maine Coast Fishermen's Association (MCFA) is an industry-based nonprofit that identifies and fosters ways to restore the fisheries of the Gulf of Maine and sustain Maine's fishing communities for future generations. During my time at MCFA, I worked on a number of projects, including a fisheries primer update, producing an episode of Maine Coast Dock Talk, and summarizing sector statistics. I also piloted a project on the history, importance, and efficacy of the Portland Fish Exchange. The fish exchange ensures both fair prices for fishermen and high quality products for consumers and wholesalers, as well as being a staple of Portland's working waterfront.

Kochen-Specker Uncolorability in Fives

SAMUEL SWAIN '18

Mentor: Manuel Reyes

Inspired by the mathematical application of the Kochen-Specker theorem from quantum physics, we attempt to assign the colors black and white to all the 3-dimensional vectors over the integers modulo any power of 5 such that every orthogonal triple has exactly one white vector and two black. We show that this is impossible using a counting argument that incorporates elements from calculus, number theory, linear algebra, and abstract algebra. This tells us that there is likewise no such coloring of the rank-1 projection matrices over those same rings, which we hope will inform an attempt to determine the colorability of symmetric idempotent 3x3 matrices over the 5-adic integers.

3D Sonar Mapping of Coral Reef Topography in Mo'orea, French Polynesia

PACIFICA KITREA TAKATA-GLUSHKOFF '19

Mentor: Jim Hench, Duke University Marine Laboratory

Corals have complex structures, which not only support a rich diversity of benthic species, but also affect hydrodynamic flow through reef systems. I worked with the Hench Lab to characterize coral reef topography using a 3D sonar scanning system on multiple 100 m3 sites in the back-reef of Mo'orea, French Polynesia. Using these 3D maps, the lab will develop a metric for multi-scale reef roughness, and also study how coral topography affects hydrodynamic processes. I helped construct and deploy measuring equipment, digitally stitched together photo-mosaics of our sites, analyzed the distribution of various coral species in each site, and developed lesson plans based on our research. I also worked with the Te Pu 'Atiti'a Cultural Center, interviewing local fishermen on their knowledge of ocean currents.

An Environmental History of Dianchi

ELIZABETH W. TARBELL '17

Mentor: Sakura Christmas

Near the city of Kunming in southwestern China lies Dianchi: a 115-square-mile lake steeped in the vibrant cultures of Yunnan Province's population, reflecting the rich mosaic of China's ethnically diverse borderlands. The lake is central to the city—and region's—past and present identities. Having inspired Qing Dynasty poets to write vivid couplets about its pristine qualities and grandeur, the lake and its ecosystem were altered in the wake of Mao's Great Leap Forward, beginning on New Year's Day in 1970, and during Kunming's rapid industrialization at the turn of this century. I traveled to Kunming to collect primary and secondary sources from the Yunnan Provincial Library and its archives and to take site visits to the lake itself, in order to craft a preliminary environmental history of Dianchi.

An Evolutionary and Computational Framework for Spatial Cognition

LIAM TAYLOR '17

Mentor: Eric Chown

Whether biotic or robotic, agents acting in the real world must solve spatial problems. An agent's spatial system, which includes its cognitive ability to perceive, understand, internalize, and respond to space, governs much of its behavior as it navigates and solves problems. The development and function of these spatial systems are constrained by both computational and evolutionary rules. Here, I detail a framework in which baseline navigational abilities (like dead reckoning) are expanded by incorporating external reference points. In highly cognitive agents like some mammals, these building blocks help assemble complex internal representations of space. In highly social agents like some insects, these basic abilities contribute to emergent, swarm-based problem-solving strategies. Comparing these convergent strategies helps emphasize the most important factors for effective spatial reasoning.

SEM Analysis of Plutonic Lithics from the Akaroa Volcanic Complex, New Zealand

ELIZABETH TEETER '18

Mentor: Rachel Beane

Plutonic Lithics are fragments from a partially crystalized magma chamber brought up during a volcanic eruption. They can be used to connect magmatic processes occurring beneath the crust with erupted material. Six thin sections from different plutonic lithics from the Akaroa Volcanic Complex, New Zealand, were analyzed using the Scanning Electron Microscope to characterize variation within the chamber. Cathodoluminescence maps revealed growth zonation within plagioclase grains and variable amounts of late interstitial growth between grains. Samples with less interstitial material are interpreted to have undergone greater degrees of compaction that would have squeezed out liquid magma from between grains. Electron Backscatter Diffraction data shows stronger crystallographic-preferred orientation of plagioclase for samples with less interstitial material, consistent with the interpretation of compaction within the chamber.

The Effect of Added Stress and Abiotic Factors on the Growth Rate of *Laminaria digitata* on Kent Island in New Brunswick, Canada

MICHAEL WALSH '19

Mentor: Don Dearborn

Laminaria digitata, a large brown macroalgae commonly referred to as horsetail kelp, grows abundantly in the sub-littoral intertidal zone along North Atlantic coastlines. Interested in determining if kelp responds to different levels of added stress in different ways, I inflicted high and low stress on the blades of eighty samples of kelp and calculated overall growth rate. Certain abiotic stressors that I could not control for, like temperature and pH, were accounted for. Since algal cells expend more energy trying to strengthen present cells instead of growing new cells while under stress, I expected the growth rate of the samples with high stress to be more negatively affected compared to the growth rate of samples only under some stress or low stress. My findings support this hypothesis.

Maine Center for Economic Policy

JACK WEISS '17

Mentors: Garrett Martin and Jody Harris, Maine Center for Economic Policy

The Maine Center for Economic Policy provides accurate and effective economic research and analysis in a commitment to ensuring a better economic future of low and moderate income Mainers. In accordance with this mission, I wrote several blog posts highlighting the future for tax expenditure reform, the effects of new federal overtime legislation, and the need to support adult post-secondary education in Maine. My main research involved identifying and quantifying the amount of lost federal funds in Maine across an array of disciplines. Through my findings, it appears Maine loses close to $700 million in funds that could be used to help Mainers make ends meet, with the majority of the losses occurring in health services.

Photophysical Properties of 2-Naphthol and the Effect of Complexation with β-Cyclodextrin

JONATHAN WELCH '17

Mentor: Kana Takematsu

Photoacids are molecules whose acidity increases following ultraviolet excitation. This aspect allows control of their proton loss, which is important in the study of proton transfer in confined environments. This research looked into the interaction of 2-naphthol, a photoacid, with the hydrophobic interior of β-cyclodextrin, a cyclic sugar. As a control, absorption and fluorescence properties of 2-naphthol in water were studied, which then allowed use of the Förster cycle and a kinetic model to characterize ground- and excited-state acidity (pK_a =9.4, pK_a^* =2.7). Then, 2-naphthol was studied in the presence of β-cyclodextrin, which bound the neutral photacid (K=1325 M^{-1}) through hydrophobic interactions and prevented deprotonation of the bound species. These results set up future research into the binding effects of β-cyclodextrin on bi-functional photoacid aminonaphthols.

SymmetryWorks!

BRIDGET WENT '17 AND SON NGO '17

Mentors: Sean Barker, Mohammad Irfan, and Bill Barker

In this project we developed a software suite for generating wallpaper patterns, inspired by the research of Professor Frank Farris from the University of Santa Clara. The software, called *wallgen*, allows a user to select from seventeen wallpaper types, categorized by their symmetry group, and adjust parameters to create a symmetrical pattern starting with a color wheel or user-input photograph. The two principal endpoints were to improve the software's core algorithm and to redesign the user interface for artists who may not understand the mathematical underpinnings. The performance enhancements were carried out using multithreading: a technique that exploits multiprocessor systems to render chunks of the image simultaneously. The user interface design was steered by two user-testing sessions to collect feedbacks on the usability of the software.

Community Matters in Maine Summer Fellowship at Mid Coast Hunger Prevention Program

MARGARET (DAISY) WISLAR '18

Mentors: Karen Parker and Mary Turner, Midcoast Hunger Prevention Program ; Michelle Vazquez-Jacobus and Eileen Johnson

A number of projects were completed during this summer fellowship. This includes researching senior hunger in the Midcoast area, and collaborating with local stakeholders and partner organizations to assess need. In addition, research was completed on the viability of licensing Mid Coast Hunger Prevention Program's kitchen as a commercial kitchen to be leased by local food producers. This fellowship also included completing a comprehensive assessment of volunteer experience—including conducting a series of focus groups and a survey, and analyzing all findings in a series of annual reports. The final project, in collaboration with the Food Security Coalition of Mid Coast Maine, was creating operating manuals and job descriptions for local food pantries in need of effective succession plans.

Synthesis of a Cobalt (I) Catalyst for C-H Activation

BEN WOLF '18

Mentor: Richard Broene

Alkanes are a large component of natural gas and petroleum, but cannot be used for many reactions other than combustion. Carbon-hydrogen bond activation with transition metal catalysts is a cost-effective and selective reaction that will replace the energy-intensive process needed to react alkanes in more useful manners. This research was conducted to synthesize and test the catalytic effects of a cobalt (I) catalyst for carbon hydrogen bond activation on phenyl groups. The catalyst was successfully synthesized, and carbon-hydrogen bond activation was observed in non-catalytic reactions. To observe the mechanism of carbon-hydrogen bond activation, an enyne compound needed to be synthesized. However, the synthesis did not form the structure we had hoped to observe, so the mechanism of the reaction is still unknown.

New Mainers and the Law: Policy and Policing among Portland's African Populations

LILY WOODWARD '17

Mentor: David Gordon

My research this summer looked at the relationship between immigrants and refugees—"New Mainers"—and the law. Focusing primarily on African communities in the greater Portland area, I gained insight into the path of a newly arrived refugee, witnessed the frustrations of accessing legal services as an immigrant, and worked directly with clients to overcome the cultural and language barriers inherent in these processes. It is my hope that the knowledge gained through this fellowship will allow me to help create better policies and facilitate cross-cultural understanding in Maine.

Reproducing White Spaces through Racial Diversity Discourse on College Campuses: A Case Study of Bowdoin College

PAMELA ZABALA '17

Mentor: Theo Greene

Recurring incidents of racial bias highlight a troubling paradox in higher education: as colleges and universities have increased efforts to make their campuses more racially and ethnically inclusive, students of color still perceive the campuses as hostile spaces for racial and ethnic minorities. The goals of this research are to examine the extent to which administrative discourses around racial and ethnic diversity contribute to a college's racial climate and to situate Bowdoin within the ongoing national conversation on racial and ethnic inclusion in higher education. I draw on archival, ethnographic, and interview data to understand what discourses around racial diversity and bias are used at Bowdoin, the kinds of spaces these discourses create, and how students of color navigate these spaces.

Assessing the Localization and Developmental Function of Semaphorin 1 and 2 in Embryonic and Adult Tissue of *Gryllus bimaculatus*

DENNIS ZAMBRANO '17 AND SARA SPICER '18

Mentor: Hadley Horch

The auditory system of the *Gryllus bimaculatus* cricket is damaged by the removal of the auditory organ in the foreleg, thereby depriving the prothoracic ganglion of sensory input. Following this deafferentation, there is unusual regrowth of dendrites across the midline of the ganglion, allowing new synapses to be established with the remaining sensory axons. The expression of two guidance proteins, semaphorin 1a and 2a, is modulated during dendritic rearrangement. Given that these proteins are implicated in the dendritic reorganization, we hypothesize that their function during adult regrowth may recapitulate their normal developmental role. We investigated the effect of inhibiting the expression of sema1a and sema2a on nervous system development; we also intend to characterize the localization of sema1a and sema2a mRNA in adult prothoracic ganglia.

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