Ohio Wesleyan University

PATRICIA BELT CONRADES
SUMMER SCIENCE RESEARCH SYMPOSIUM

SEPTEMBER 16, 2013

DR. JAMIE LYNN HARDEN

OWU '06, POSTDOCTORAL ASSOCIATE, THE ROCKEFELLER UNIVERSITY

"The skills I learned while doing summer research at Ohio Wesleyan University made me one of the most prepared students in my graduate school class. Currently, as a postdoctoral scientist at one of the most prestigious biomedical research institutions in the world, I honestly believe I would not be here today if it were not for the excellent foundation, and pure excitement for research and science, that I received while at OWU."

THE PATRICIA BELT CONRADES SUMMER SCIENCE RESEARCH SYMPOSIUM

Science, mathematics, and technology continue to increase in importance as the world becomes smaller and more interdependent. Through ongoing research, scientists can help solve global problems—from eradicating infectious diseases to discovering new sources of clean, safe energy.

Now in its twenty-first year at Ohio Wesleyan, the Summer Science Research Program, which culminates in today's Patricia Belt Conrades Summer Science Research Symposium, encourages students to tackle tough research issues by offering an intensive 10-week opportunity to work with seasoned, accomplished mentors both on and off campus. The posters you see here today depict the research results. Please ask the students any questions you wish; they are proud and happy to tell you what they learned and why it matters.

Contents

Atrium, Schimmel/Conrades Science Center

Monday, September 16, 2013 at noon

Opening remarks by President Rock Jones followed by student poster presentations

Thoughts from the Director

Ohio Wesleyan University encourages students to take the theory learned in the classroom and put it into practice in the real word. While many new curricular initiatives are providing these opportunities for all OWU students, the Summer Science Research Program (SSRP) has been modeling this concept for more than two decades.

In this rich and varied program, students spend ten weeks in the summer working side by side with faculty mentors on research projects that are connected to the students' particular scientific interests. At larger institutions, undergraduate students join an existing research group consisting of graduate students and post-doctoral fellows. At Ohio Wesleyan, that's not the case. Here, students are the central researchers in their projects. They participate in all the steps of the research process, taking ownership of the successes, the failures, and the knowledge gained. Throughout this process, they grow into mature, self-directed, confident investigators who add their own pieces of knowledge to the greater body of scientific understanding.

Today, the students participate in another very important part of scientific work: explaining their research posters to scientists and nonscientists alike. As you talk with the students, you will appreciate the depth of their understanding. They can explain their work because they understand the fundamentals of the project and have recognized and pondered its nuances.

Many of these students will present again at major meetings of national scientific societies, interacting with the most prominent scientists in their fields of interest and making the connections that will help them as they further their work in graduate school or in an immediate scientific career. Today may mark the first step in a long lifetime of professional achievement.

We are grateful to Dr. Nancy Schneider '64 for providing the endowed funds that make this celebration of scholarship a reality each year.

In the following pages, you'll meet Ohio Wesleyan students who conducted research both on and off the campus, as well as students from other colleges who carried out research on our campus under a National Science Foundation Research Experiences for Undergraduates (REU) Grant awarded to our faculty in physics, astronomy, computer science, and mathematics.

Congratulations to all who participated in this exceptional research program.

Barbara Andereck
Summer Science Research Program Director
Assistant Provost
Professor of Physics and Astronomy

The Making of a Scientist

In Ohio Wesleyan's Summer Science Research Program (SSRP), students learn quickly that authentic research is quite different from classroom labs—more challenging, more creative, more frustrating, and, ultimately, more rewarding.

I have always actively involved students in my research projects during the academic year and the summers. The most rewarding part is watching the students grow as scientists, seeing them take command of a research project, and knowing that they are gaining the confidence to speak and act as scientists. Science cannot be learned solely from a book. Science must be experienced through research, and at OWU, we encourage students to plunge in, preparing them to be successful researchers both at OWU and at other universities. Many first-year students are surprised to learn that they can contribute in substantive scientific research from the moment they arrive on campus. At Ohio Wesleyan, research is not just for the few.

During the Symposium this afternoon, you will have the opportunity to interact with 24 students who performed research at OWU mentored by OWU faculty members, seven students from universities other than OWU who worked on campus with OWU faculty, and 12 OWU students who performed research off campus at other universities or in other countries. There is no doubt that the results presented here today are exciting and novel. However, equally exciting is the opportunity for you to speak with each of these young scientists about what discoveries they have made.

Enjoy the Symposium – and be sure to learn something new!

Laura Tuhela-Reuning
Department of Botany-Microbiology
Department of Zoology
Scanning Electron Microscopist
Summer Science Research Program Assistant Director



THE PATRICIA BELT CONRADES SUMMER SCIENCE RESEARCH SYMPOSIUM ENDOWMENT

In 2006, Dr. Nancy Reynolds Schneider '64, established an endowment to name the Summer Science Research Symposium after her good friend and fellow OWU alumna, Patricia Belt Conrades '63.

Mrs. Conrades is a volunteer registered nurse and homemaker, and a member of Ohio Wesleyan's Board of Trustees. She regularly assists in the operating room of Boston's Mount Auburn Hospital and is also a nurse with Volunteers in Medicine, assisting the poor in Stuart, Florida. Dr. Schneider is a highly regarded Professor of Pathology and Director of the Cytogenetics Laboratory on the faculty of the University of Texas Southwestern Medical Center in Dallas. She also has served on the Ohio Wesleyan Board of Trustees.

Mrs. Conrades and Dr. Schneider share a commitment to the sciences, and are both examples of individuals who have enjoyed successful careers in science. The support of Mrs. Conrades and her husband, George Conrades '61, a member of the OWU Board of Trustees, and Dr. Schneider and her husband, John Schneider, continues to strengthen the science and mathematics programs at OWU.

THE C. PATRICIA FERRY SUMMER SCIENCE RESEARCH PROGRAM ENDOWMENT

In 2008, Patricia Ferry '53 established the C. Patricia Ferry Summer Science Research Endowment in recognition of the program's value as an integral part of the liberal arts experience. The endowment that will fund the program in perpetuity follows Ms. Ferry's support of the program through gifts she has made annually for several years.

Through her contacts with SSRP participants, Ms. Ferry has observed how the program introduces students to the excitement of science and original research and provides familiarity with the many career options available in the disciplines.

Ms. Ferry's interest in the sciences is longstanding, including her years at Case Western Reserve University, where she worked in the medical school directing its medical education program. She graduated from Ohio Wesleyan with majors in psychology and sociology and as a member of Alpha Xi Delta sorority.

Special Acknowledgments

Sources of Support for the 2013 Summer Science Research Program

Harry Phillip Bahrick Summer Research Fund
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The Student-Faculty Endowed Research Fund in Chemistry
Ohio Wesleyan University Provost and Academic Affairs Office

Support for the Patricia Belt Conrades Summer Science Research Symposium

Dr. Nancy Reynolds Schneider '64

Board 1

NATHAN TURNWALD AND BRAD TURNWALD

Faculty Mentor: Dave Markwardt
Department of Zoology

Polyamines are small molecules in many organisms, including humans, that are necessary for growth and survival. Polyamines have been shown to affect certain pathways, and we are interested in finding all of the genes that polyamines regulate. We have worked on developing a method to separate polyamines in a mixture for the detection and quantification of polyamines in fission yeast.

POLYAMINE-DEPENDENT GENE EXPRESSION IN *SCHIZOSACCHAROMYCES POMBE*

Polyamines are organic compounds that consist of two or more primary amino groups (NH2). In eukaryotes, four polyamines play important roles in cellular function: putrescine, spermine, spermidine, and cadaverine. As cations, polyamines bind to nucleic acids, such as DNA and RNA. Although their actual function is not completely clear, they appear to have a host of physiological functions and are necessary for survival, with roles in cell division and growth. One such role for polyamines is action as a regulator in a nonsense-mediated decay (NMD) pathway involving the enzyme antizyme. NMD is an mRNA surveillance system that targets and specifically degrades transcripts with premature termination codons, and the antizyme pathway is one model in which polyamines have been shown to regulate stability of the antizyme transcript which inherently contains premature termination codons. In the Markwardt lab, we are interested in identifying other genes besides antizyme that are regulated by polyamines in an NMD-dependent manner. To investigate, we are cloning knockout fission yeast that lack the gene for the enzyme that synthesizes polyamines, and a double knockout strain that lacks polyamine synthesis and NMD function. By conducting experiments in which polyamine levels are controlled in the knockout strains, RNA sequencing will allow for analysis of gene expression levels. Specifically, we will be interested in the subset of genes that are regulated by polyamines and NMD. Before these tests can be conducted, a method for detecting intracellular polyamine concentration in fission yeast must be developed and this has comprised most of this summer's work. Using high-performance liquid chromatography to separate the four polyamines based on size and charge and fluorimetry for polyamine detection, we have developed a method for separating and detecting the polyamines. Further work will continue to improve resolution of separation of these compounds.

Board 2

SAM SONNEGA AND MYRIEM IBOURK

Faculty Mentors: Shala Hankison
and Tami Panhuis
Department of Zoology

The major histocompatibility complex (MHC) is a family of genes involved in our immune regulation. Aside from their immune function, the study of the genes in the MHC may be important in mate choice, allowing organisms to increase their offspring number or health. Our research this summer was focused on whether females of the U.S. sailfin molly *(Poecilia latipinna)* choose males based on MHC genes. By DNA sequencing a sample of 60 individuals, we hope to determine the role of sexual selection in mate preference.

MATE PREFERENCES ASSOCIATED WITH MHC ALLELES IN THE SAILFIN MOLLY, *POECILIA LATIPINNA*

The Major Histocompatibility Complex (MHC) is a highly polymorphic gene region found in most vertebrates which encodes antigen presenting molecules involved in immune response. Many selective forces drive and maintain the genetic diversity found in this region, one of which may be sexual selection. In the sailfin molly fish, *Poecilia latipinna,* female preference drives the evolution of many male traits. Optimal combinations of MHC alleles may contribute to an increase in offspring fitness, thus influencing mate preference. In this study, we seek to determine if female *P. latipinna* prefer males based on diversity in the MHC class-IIB region. Specifically, this summer we obtained genomic DNA samples from 60 individuals. The DNA isolated will be sequenced using an adapted 454 sequencing platform. In the future, we plan to perform preference tests on the females in this population once the genotypes are known.

Board 3

HAYLEY WINSLOW

Faculty Mentor: Chris Wolverton
Department of Botany and Microbiology

Plants are able to sense gravity (meaning they know which way is up and which way is down), so when the plant is rotated at an angle, the plant senses the change and reorients itself to a vertical position. This process involves a plant hormone called auxin, and the proteins that transport the hormone, called PINs. PIN3 may be more active at lower angles of rotation such as 30 and 60 degrees, while PIN7 may be more active at higher angles such as 90 and 120 degrees. To test this, plants with a mutation in the PIN7 protein were rotated at these four angles and the angle of the root tips were measured every four hours for twenty-four hours to assess the response.

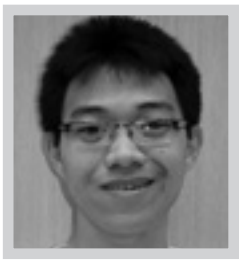
UNDERSTANDING THE ROLE OF PIN3 AND PIN7 IN THE GRAVITROPIC RESPONSE OF ARABIDOPSIS

Plants rely on a number of tropisms to respond to stimuli and grow well in their environments. Plants can sense gravity, and prefer to grow vertically. When a plant is gravistimulated by being rotated at a different angle, the root tip responds by curving back down to its preferred position. This differential growth is accomplished when PIN proteins in the root tip transport the plant hormone auxin to the new bottom of the root tip in the elongation zone, where growth is inhibited. This allows for faster growth of the other side of the root, resulting in curvature. There are five PIN proteins in the root tip (PIN1, PIN2, PIN3, PIN4, and PIN7) and they all act as auxin efflux carriers. A plant with a single mutation in one of these proteins will usually not be severely inhibited in a gravitropic response, possibly because they exhibit functional redundancy. In this experiment, pin7 mutants were rotated at 30, 60, 90, and 120 degrees and were photographed every twenty minutes for twenty-four hours. The angle of the root tip was measured at every four hours of the response to determine if the plants responded more quickly at lower or higher angles. Previous research suggests that PIN7 is more active at higher angles of gravistimulation, while PIN3 is more active at lower angles. In order to better understand these results and to further test this hypothesis, the same test needs to be executed using pin3 mutants and wild type plants.

Board 4

KHOA T LAM

Faculty Mentor: Katherine Hervert
Department of Chemistry



Fluoride ions are important to humans but may lead to skeletal and dental health issues when overexposed. Measuring the fluoride ions often requires a large amount of organic solvents and time. My summer research was to synthesize various organic compounds that are essential to the detection of fluoride ions and solubilize them in water to reduce wastefulness of resources and time.

A NOVEL, AQUEOUS FLUORESCENT FLUORIDE PROBE USING COUMARIN DERIVATIVES

Fluoride ions contribute significantly to human skeletal and dental health and have been added to everyday products (toothpaste, milk). Concentration of fluoride can be detected by using fluorescence spectroscopy to measure the concentration of the free fluorescent coumarin chromophores which are displaced from the bidentate Zr-EDTA/coumarin complex by the fluoride ions. Various derivatives of 7-hydroxy-4-methyl coumarins were synthesized from a modified Pechmann condensation reaction, in which various derivatives of resorcinol and ethyl acetoacetate were reacted in the presence of methanesulfonic acid at room temperature. The products were purified by recrystallization from glacial acetic acid. Purified coumarin derivative products were sulphonated in the presence of chlorosulfonic acid at reflux to become soluble in water for future fluoride detection studies.

Board 5

ROBERT ELDER

Faculty Mentor: Bob Haring-Kaye
Department of Physics and Astronomy

Atomic nuclei with an odd number of protons and neutrons ("odd-odd" nuclei) are considered the most complicated ones to study. Like nucleons tend to couple together, simplifying their contribution to the nuclear structure. Odd-odd nuclei have both an unpaired proton and an unpaired neutron which have a more complicated effect on the nuclear structure because of the many different ways that they can arrange themselves in the nucleus. Despite their complexity, systematic and predictable patterns have emerged in a variety of their structural characteristics, including how their energy levels are grouped and how their mass is distributed as they spin. This work studied the fundamental structure properties of the odd-odd ^{70}As nucleus with the goal of seeing how similar it is to its odd-odd neighbors. Our research showed that ^{70}As is considerably more similar to ^{72}As than to ^{68}As, indicating a strong sensitivity of the overall structure on the number of neutrons.

EVOLUTION OF COLLECTIVITY WITH SPIN IN ^{70}As

The proton-rich, odd-odd As isotopes indicate a rather rapid progression from structures dominated by single-particle excitations (^{68}As) to those dominated by collective rotations at high spin (^{72}As) as the number of neutrons increases. Occupation of the $g_{9/2}$ single-particle orbital by the odd (unpaired) proton and neutron appears to drive the onset of collective rotations (and thus deformation) in these isotopes. Previous studies of ^{70}As indicate transitional behavior, showing signatures of both single-particle and collective behavior, but more experimental information is needed to confirm this picture. In this study, gamma-ray coincidence measurements of the odd-odd ^{70}As nucleus produced by the ^{55}Mn(18O, 3*n*) reaction at 50 MeV have been performed and analyzed. The gamma-ray coincidence events, energies, and relative intensities were measured using a high-resolution Ge array at Florida State University consisting of 10 detectors. Several previously discovered gamma-ray transitions between excited states were confirmed and additional transitions have been placed in the level scheme. In particular, "missing" negative-parity, odd-spin states have been found which fill in the gaps left behind in previous ^{70}As level schemes. The high-spin, positive-parity states show strong similarities to states in neighboring odd-odd nuclei which are also suggested to be based on the occupation of the $g_{9/2}$ orbital. Kinematic moments of inertia, analogous to the classical moment of inertia of a rigid body, were calculated for the high-spin states and indicate a convergence to the expected rigid-body value. Theoretical shape calculations indicate a nearly prolate (American football) shape is likely at high spin. These calculations also suggest a possible oblate (disc-like) shape associated with some of the low-lying negative-parity states.

Board 6

JESSICA DEMES

Faculty Mentor: Scott Kelly
Department of Zoology

Play behavior encompasses social play, play fighting, and locomotor play. Locomotor play is vigorous and seemingly purposeless behavior observed in young birds and mammals. Although potentially costly (e.g., elevated levels of predation, injury, and energetic expenditure), it is hypothesized that locomotor play facilitates muscular and neural development in young individuals and these changes may persist into adulthood. Here, we examined whether elevated locomotor-play behavior has evolved as a correlated response in the context of artificial selection for increased voluntary wheel running behavior.

PLAY BEHAVIOR IN MICE SELECTIVELY BRED FOR HIGH VOLUNTARY WHEEL RUNNING

Play behavior encompasses social play, play fighting, and locomotor play. Locomotor play is vigorous and seemingly purposeless behavior observed in young birds and mammals. Although potentially costly (e.g., elevated levels of predation, injury, and energetic expenditure), it is hypothesized that locomotor play facilitates muscular and neural development in young individuals and these changes may persist into adulthood. Here, we examined whether elevated locomotor-play behavior has evolved as a correlated response in the context of artificial selection for increased voluntary wheel running behavior. We utilized four replicate lines of mice selectively bred for high voluntary wheel running (HR lines) on days 5 and 6 of a six-day test, and four non-selected Controls (C). HR adult mice run >70% more revolutions per day (on days five and six) as compared with C lines and display a number of behavioral, morphological, and physiological adaptive changes. For the current study we examined locomotor-play behavior 2-7 days following weaning in mice from generations 20 and 67 of the ongoing selection experiment. We observed two forms of previously defined locomotor-play behavior: (1) very rapid, horizontally directed jerk-run sequences and (2) rapid 'bouncing' in a vertical direction. We used focal sampling to continuously record behavior of entire cages during the first two hours of the dark cycle.

Board 7

SHANE GORBETT

Faculty Mentor: Shala Hankison
Department of Zoology

Mating behaviors of the U.S. sailfin molly *(Poecilia latipinna)* have been studied in depth in isolated male-female pairs, however, in this study I focused on how a social environment would influence and change the mating behaviors of male sailfin mollies. I observed males in three differing male: female ratios of 1:5, 2:4, and 3:3 for mating, courtship, and competition behaviors. I hypothesized that when there was relatively more females, males would perform more mating and courtship behaviors. Conversely, when there was relatively fewer females, males would exhibit less mating and courtship behaviors and more competitive behaviors. In more male biased environments males perform more male competition behaviors because the males must compete more vigorously with the other males for the few available females and males exhibit less mating and courtship behaviors because the males must spend more time and energy competing with the other males. This study demonstrates that in a more male biased social environment male sailfin mollies put less time and energy into mating behaviors because more time and energy is spent competing with other males for the low availability of female mates.

IMPACT OF MALE: FEMALE RATIO ON MATING BEHAVIORS IN SAILFIN MOLLY

Studies on intersexual mating competition show that an increase in the proportion of males leads to increased male-male aggression and decreased courtship. Mating behaviors of the U.S. sailfin molly *(Poecilia latipinna)* have been studied in depth, however primarily in a 1:1 male: female ratio. I hypothesized that in a more female biased ratio males would exhibit a higher frequency of mating and courtship behaviors and conversely, in a more male biased ratio males would demonstrate a decrease in courtship behaviors and mating frequency and an increase in male competition. I observed male *P. latipinna* in three differing male: female ratios of 1:5, 2:4, and 3:3 for mating, courtship, and competition behaviors. As predicted there was a significant increase in mating and courtship frequency of males in the 1:5 male: female ratio than in the more male biased ratios. Males in more male biased male: female ratios showed slightly, but not significantly, more aggression and competition behaviors compared to males in more female biased environments. In male biased environments male competition increases, as males must compete more vigorously for a lower abundance of potential mates. This study demonstrates that in a social environment with an increased proportion of competitors male *P. latipinna* put less time and energy into mating behaviors, thus fewer copulation opportunities, because more time and energy is spent competing with other males for the low abundance of potential mates.

Board 8

NATHAN MADONICH

Faculty Mentor: Chris Wolverton
Department of Botany and Microbiology

Understanding how plant roots sense and respond to different environmental settings is important for a general understanding of plant biology and for applicable usage such as a garden, park, or agricultural setting. Plants respond to many things in the environment, but the four main stimuli are gravity, light, touch and water. This summer our lab focused on understanding the basics of lateral root structure of *Arabidopsis thaliana* under conditions of drought. By making water less available to the plant, we were able to observe changes in angle and growth between plants with access to water and plants that had less access to water.

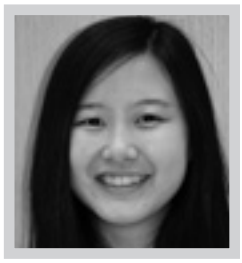
UNDERSTANDING DROUGHT-STRESS IN THE LATERAL ROOTS OF ARABIDOPSIS THALIANA

Plants exhibit many different tropisms to react to the surrounding environment. The main tropisms include phototropism, gravitropism, thigmotropism and hydrotropism, which are the responses to light, gravity, touch and water, respectively. There is published information on the first three listed tropisms, but hydrotropism has remained largely unexplored. This was because of the inability to separate a hydrotropic response from the other tropisms. In this experiment, Polyethylene Glycol 8000 (PEG8000) was placed in front of the growth path of a lateral root of *Arabidopsis thaliana* grown on a plated growth medium. PEG8000 is a sugar alcohol that lowers the water potential of the area where it is applied, and was used to induce a drought stress response. The roots of Arabidopsis were scanned and measurements of the lateral root angle and length were taken. Preliminary results suggest that the localized drought- stress causes a deviation from the intended set point angle and increased growth rate of the stressed lateral root. It is thought that this response allows the plant to navigate around the low water potential area in search of higher water potential areas.

Board 9

JESSICA MARTIN AND THIN NU YEE

Faculty Mentor: Lynda Hall
Department of Psychology



Our current study has been designed to examine the relationship between stress and accessibility of information from knowledge in older adults. Although people have reported experiencing accessibility problems when under stress, there are not many studies that have looked at this relationship objectively. Using accessibility/availability ratio (A/A ratio), we will explore the effect of stress on older adults' ability to access names and words from their memory.

THE RELATIONSHIP BETWEEN STRESS AND MEMORY IN COGNITIVE AGING

Past research has demonstrated that people perform worse on tests of episodic and working memory when under stress. People have also reported that their ability to access specific names from their memory has declined under stress (Cohen and Faulkner, 1986). Few studies have been done that directly examine the effects of stress on accessibility of information from semantic memory, possibly due to the difficulty in measuring accessibility of semantic knowledge. The A/A ratio, the ratio of accessible knowledge to available knowledge (Bahrick, Hall & Baker, 2013), has been demonstrated to be sensitive to age related changes in semantic memory. The present study has been designed to further explore the relationship between stress and accessibility. We spent a much of our summer reading literature on stress and memory, brainstorming a strong hypothesis, finding ways to best design our study for older adults, developing reliable measures of working memory and semantic memory access, and pilot-testing those measures. We will finalize our measures for this study and will have them ready for the actual data collection.

Board 10

LAURA ROBISON AND NIVEDITHA MANIVANNAN

Faculty Mentor: Danielle Hamill
Department of Zoology

Caenorhabditis elegans is a well studied nematode (a small worm) and is used as a model to learn more about all animals. Our goal this summer was to characterize several related types of nematodes. We identified six species through DNA sequencing; two of which may be new species. Using immunofluorescence and light microscopy, we found differences in the early development of these species in comparison to *C. elegans*. This research will provide insight into the flexibility of early development in related species.

SEQUENCING & PHENOTYPIC CHARACTERIZATION OF FREE-LIVING NEMATODES

Caenorhabditis elegans is a commonly used model organism belonging to the rhabditid group of nematodes (roundworms). We have recently isolated and are now studying several other rhabditid nematodes, with a goal of comparing them to each other and to *C. elegans* using a combination of molecular, genetic, and phenotypic approaches. We sequenced a highly conserved 18s rDNA gene as part of our analysis to establish which species we are working with. Based on these sequences, we believe that we have six different species of nematodes, including a couple of species that have not been previously described. We also performed genetic crosses to support the molecular data that the worms belonged to different species. Furthermore, using light microscopy and immunofluorescence, we observed early embryonic development in these species. *C. elegans* has a stereotypical pattern of development that is highly reproducible in all individuals. In some of these other nematodes, we noticed differences in the mitotic spindle alignment and timing of divisions in comparison to *C. elegans*. This illustrates that several essential elements of early embryonic polarity in *C. elegans* do not appear to be conserved in some nematodes. We plan to further document and analyze these differences. We believe that comparative studies like this will not only help us better understand an important and diverse phylum of animals, but they will also help us understand cell division and developmental patterning on a broader scale.

Board 11

DANIEL FIREHAMMER

Faculty Mentor: Mark Mitton-Fry
Department of Chemistry

Organic chemistry is the study of the properties and reactivity of carbon based compounds. Our research is focused on the unusual expansion of a four membered carbon ring to a five membered ring using ozone. This summer, the substrates that will be required for further research were prepared, and the methods used in that research were optimized. This research will provide insight into the properties of both ozone and small, strained ring systems.

GREEN, OZONE-BASED BAEYER-VILLIGER REACTION OF STRAINED KETONES

The Baeyer-Villiger reaction describes the oxidation of a ketone to an ester, generally using a peracid oxidant. Recently a novel Baeyer-Villiger was observed on a 3-arylcyclobutanone, using ozone at low temperatures to generate a ring-expanded lactone. Cyclobutanones are unique in their inherent substantial ring strain, allowing them to relax by way of ring expansions that are not normally observed in larger ring systems. The goal of this research is to understand the scope and mechanism of this reaction.

3-phenylcyclobutanone was chosen as the initial substrate due to its structural simplicity and UV absorption. The effects of ring size, steric hindrance, and electronic effects will also be studied using varying sized cyclic ketones and differentially substituted 3-phenylcyclobutanones. To date, numerous substrates have been synthesized and those syntheses optimized. Authentic samples of the ring-expanded products have been sythesized using the traditional Baeyer-Villiger reaction with oxidant mCPBA and the corresponding cyclic ketone. Gas chromatography conditions have been developed and optimized to allow for the analysis of reaction kinetics. The ozone oxidation was shown to occur on 3-phenylcyclobutanone, proving the viability of this research.

Board 12

ALEX COOK

Faculty Mentor: Christian Fink
Department of Physics

For most of the 20th century, neurons were thought to be the only cells in the brain involved in information processing, while glial cells were thought to be merely supportive cells. Now it is known that astrocytes, a type of glial cell which communicate via calcium signaling, may also be involved in information processing. In collaboration with a lab which records the activity of neurons and astrocytes in a dish, we developed an algorithm to automatically detect when astrocytes are activated, in order to better quantify the complex interactions between neurons and astrocytes.

AUTOMATED DETECTION OF CALCIUM EVENTS IN ASTROCYTE NETWORKS

Recent experimental evidence indicates that astrocytes actively contribute to information processing in the brain. However, exactly how astrocytes interact with neurons to process information is still poorly understood. In order to investigate neuron-astrocyte interactions, we collaborated with the Zochowski lab at the University of Michigan, which recorded the activity of neurons and astrocytes in culture. The activity of neurons was recorded using multi-electrode arrays, while the activity of astrocytes was monitored using the fluorescent dye Fluo-4 AM. The lab needed a method to automatically detect astrocyte calcium events, which are characterized by a rapid rise in intracellular calcium, and are therefore detected by an accompanying rise in the recorded fluorescence signal. Using MATLAB, we developed an algorithm to automatically detect these calcium events. We started by fitting piecewise, least-squares linear segments to each astrocyte's fluorescence trace. We identified onsets and offsets of calcium events based on the slopes of these line segments, using thresholds based on the mean slope and variance of each trace. Each event was also classified as either simple or complex based on the pattern of line segments between onset and offset. The astrocyte data generated by this algorithm will be combined with neuronal data in order to better understand how neurons and astrocytes coordinate their activity to process information.

Board 13

CODY M. KENT

Faculty Mentor: Edward H. Burtt, Jr.
Department of Zoology

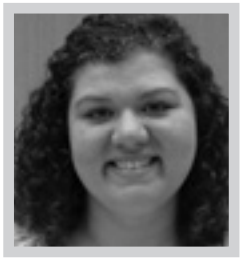
Bacteria that live among the feathers of birds are capable of destroying their feathers. One way to minimize the damage is maintenance behavior, such as preening and bathing, that clean the feathers. We sampled bacteria in the plumage of starlings weekly and observed the occurrence of maintenance behaviors. We then examined the pattern of occurrence of maintenance behavior and abundance of bacteria throughout the typical day and year.

EFFECT OF MAINTENANCE BEHAVIOR ON PLUMAGE MICROBIOTA.

Bacillus spp. capable of degrading feathers live in avian plumage (Burtt and Ichida Auk 116: 264-272. 1999) where they degrade feathers by secreting a ß-keratinase that breaks apart the ß-keratin that is the structural protein of feathers. The abundance of the bacilli fluctuates throughout the year, being highest during the winter months and lowest during the months when the birds are molting. Birds minimize the damage caused by these bacteria with pigments that increase the durability of feathers and by molting worn feathers and growing new ones. The effect of maintenance behavior, such as sunning, preening, head scratching, or bathing, and of lice and mites, which also live in the plumage, in controlling bacterial degradation is unknown. We have begun our study of the effect of maintenance behavior by describing the action patterns in detail and looking for circadian and circannual patterns of variation in European Starlings (*Sturnus* vulgaris). We captured and color banded 13 starlings and placed them in an outdoor aviary. Bacterial samples are weekly. Additionally, we describe the types of maintenance behavior observed and track the occurrence of the individual pattern and the behavior collectively over time. We plan to continue our study throughout the year to quantify circadian and circannual patterns. We hope to use information analysis to mathematically explore the sequencial organization of maintenance behavior.

Board 14

CRISSANDRA DIGGES



Faculty Mentor: Katherine Hervert
Department of Chemistry

Adenosine deaminase deficiency is a metabolic disorder that accounts for 15% of severe combined immunodeficiency in which one has a compromised immune system through the inability of lymphocytes to mature and the prevention of DNA synthesis from a buildup of dATP. Nucleoside analogs act like nucleosides in DNA synthesis and can prevent replication in infected cells. By examining the transition states of enzymes we can learn where the nucleosides attach and the conformation the enzymes adopt when bound to their respected nucleosides. Our collaborator, Dr. Brian Miller at Florida State University, will use NMR spectroscopy to see how our compound affects the conformation of adenosine deaminase when bound to ADA to better understand how nucleoside analogs function.

SYNTHESIS OF 2',5'-DIDEOXYCOFORMYCIN

Transition states in chemistry are defined by the time it takes for bonds to break and bonds to form and have a lifetime that occurs on the femtosecond time scale. We can synthesize transition state analogs that help stabilize certain conformations of enzymes to help our understanding. Some transition state analogs have different capabilities in addition to stabilizing different conformations of enzymes, such as inhibiting cancer growth and aid in the designing of antibiotics. We will synthesize 2',5'-dideoxycoformycin for our collaborator, Dr. Brian Miller at Florida State University, to see if the 5' hydroxyl group will act as an anchor within the adenosine deaminase transition state. Using NMR spectroscopy, our collaborators will investigate the mode of action of 2',5'-dideoxycoformycin and compare it to 2'-deoxycoformycin.2',5'-dideoxycoformycin and 2'-deoxycoformycin will be synthesized by following several different literature procedures and NMR spectroscopy will be used for structural analysis.

Board 15

MEGAN FRIS

Faculty Mentor: Tami M Panhuis
Department of Zoology

Although most people associate fish with laying eggs, some are capable of giving live birth. Within this group, some species of fish are able to provide more nutrients to their young during the time spent in gestation. Unique cell surface structures between the mother and the developing embryos can facilitate how efficiently nutrient transfer can occur. Using scanning electron microscopy (SEM) we plan to characterize these cellular structures at different stages of development for several closely related fish species.

USING SEM TO CHARACTERIZE AND COMPARE CELL MORPHOLOGIES OF PLACENTAL TISSUES FROM *POECILIOPSIS* FISH SPECIES

Species in the fish genus *Poeciliopsis* are viviparous, or give live birth to their young. Some species within the genus are lecithotrophic, embryos develop from yolk resources, while other species are matrotrophic, embryos develop using a continuous nutrient supply from their mothers. Matrotrophic mothers provide these nutrients with a placental-like structure called the maternal follicle and embryos have developed various anatomical structures to efficiently absorb maternal nutrients. The goal of this project is to use scanning electron microscopy (SEM) to characterize and compare the maternal and embryonic placental structures across a range of *Poeciliopsis* species, which differ in their degree of matrotrophy. We found that when species with high indexes of matrotrophy are compared, the morphology of embryonic surface epithelial cells can be very distinct from one another. Apical cell surfaces in some species are highly microvilliated while others are covered with ridges. Although structurally different, both surfaces would function to increase surface area for absorption. Embryos from lecithotrophic species vary in the appearance of elaborate cell morphologies and sometimes, simply have characteristic epidermal precursors. Maternal follicle structures also differ between *Poeciliopsis* species. Lecithotrophic follicles are thin with an acellular porous membrane covering a cell surface where the apical cell surfaces appear flat. Matrotrophic follicles differ by species, but generally tend to be thick, folded, and apical cell surfaces are covered with microvilli. Our SEM results underscore the placenta structural differences between *Poeciliopsis* species and shed light on the cell surface structures necessary for different modes of viviparity.

Board 16

SILAS W. JOLLIFF

Faculty Mentor: David Johnson
Department of Botany and Microbiology

Basically maps have been made of the tree genus *Xylopia*. The maps are of particular species within the genus and seek to show distributions of the particular range across tropical America, Africa and the Asian-Pacific region from Sri Lanka to Fiji. maps allow similar species to be compared and contrasted geographically. Maps also provide useful data for assessing species rarity for conservation purposes. Of the 180 species of *Xylopia* about 40 have been mapped so far, all from the tropical regions of Africa and Madagascar.

MAPPING THE *XYLOPIA* GENUS

Evolution and diversity of the tropical tree genus *Xylopia* is the subject of a long-term research project at Ohio Wesleyan University. *Xylopia,* a member of the mostly tropical pawpaw family, Annonaceae, is unique in the family in its pantropical distribution, and is thought to comprise about 180 species spread across tropical America, Africa, and the Asian-Pacific region from Sri Lanka to Fiji. Part of the long-term study is to determine exactly how many species exist in the genus. Through field studies and study of museum specimens from all over the world similar species are being distinguished from one another. Ecological distinctions among species as they relate to larger geographic scales are also being documented. This is where maps provide a useful visual. Maps were made using ArcGIS. Geographic data linked to the museum specimens collected were plotted as a series of individual points, in many cases according to exact longitude and latitude of the site where they were collected. Some points are in the general location of collection, as many older specimens had no coordinate data, but simply stated the village or other place name nearest to the collection site. By overlaying this point layer on different map templates found in ArcGIS maps can be generated that allow us to relate distributions of individual species to topographic or climatic features. Furthermore, maps allow similar species to be compared and contrasted geographically. Maps also provide useful data for assessing species rarity for conservation purposes. Of the 180 species of *Xylopia* about 40 have been mapped so far, all from the tropical regions of Africa and Madagascar.

Board 17

ZACHARY FORD AND CAROLINE ROY

Faculty Mentor: Jennifer R. Yates
Department of Psychology

Spinal cord injury continues beyond the primary trauma. Known as secondary injury, this increases the damage in the tissue in part by immune response. Two drugs, Methylprednisolone and 6Cl-Tryptophan attenuate different aspects of this immune reaction. Guinea pigs were used to model a compression spinal cord injury and to investigate the additive effect between these two drugs.

ATTENUATION OF SECONDARY SPINAL INJURY BY METHYLPREDNISOLONE AND 6-CL TRYPTOPHAN

Spinal cord injury is a prevalent problem in the US, affecting over one million people. In addition to the primary trauma, a process known as secondary injury further contributes to tissue damage. Immune response plays an important role in this process, specifically lipid peroxidation and quinolinic acid (QUIN) production. Both of these processes lead to death of neurons and myelin surrounding the injury. Previous research has shown effective drug interventions using 6Cl-Tryptophan and Methylprednisolone (MP), albeit separately. 6Cl-Tryptophan decreases the production of QUIN by interrupting its synthesis pathway; while MP acts as an antioxidant. Due to these drugs working on different mechanisms, our goal was to explore the possibility that they have additive effects on behavioral and structural deficits. A dorsal laminectomy at thoracic level 12 and lateral compression for 15 seconds was performed on female Hartley guinea pigs. Behavioral evaluations of both sensory (*Cutaneus Trunci* muscle reflex) and motor function (toe spread; proprioceptive placing) were used to assess injury over a twelve-day period post-injury. Results were inconclusive and more trials will be needed to determine if there is an additive effect between these drugs.

Board 18

RACHEL G. THOMAS

Faculty Mentors: Stefan S du Plessis
Stellenbosch University, South Africa Department of Biomedical Sciences
Ashok Agarwal
Cleveland Clinic Center for Reproductive Medicine

Infertile couples commonly experience depression and anxiety symptoms after an infertility diagnosis. Depression and anxiety can be treated with antidepressants, but along with loss of sex drive, they can negatively impact normal sperm function, further contributing to male infertility. Less commonly prescribed antidepressants that do not impact sexual functioning are available, and counseling has been shown to benefit the physical and mental well-being of infertile couples. This paper seeks to create an accessible resource for physicians and mental health professionals about the relationship between mental illness and male infertility as to further improve infertility diagnosis and treatment.

FERTILITY STATUS OF MEN WITH DEPRESSION AND ANXIETY

In the United States, 18.1% of individuals with a mental illness are diagnosed with an anxiety disorder, and 14.8 million have Major Depressive Disorder. Depression and anxiety symptoms can appear after an infertility diagnosis. Additionally, treatment with commonly prescribed antidepressants can contribute to infertility. The purpose of this article is to review existing literature about the relationship between mental illness and male infertility. Infertile couples experience more depressive symptoms than fertile couples and use avoidant coping styles to deal with their infertility diagnosis.

Antidepressants are used to treat depression and anxiety, however a survey of 1,022 patients on antidepressants showed that 59.1% developed sexual dysfunction and that 61% of these individuals were men. Although antidepressant-associated sexual dysfunction such as delayed ejaculation can be used to treat premature ejaculation, antidepressants negatively impact sperm parameters after prolonged use. Selective serotonin reuptake inhibitors, commonly prescribed antidepressants, decrease sperm concentration and cause abnormal sperm motility and single strand DNA damage. Infertility diagnoses can cause psychological stress and commonly prescribed antidepressants can lower sperm quality. Antidepressants less harmful towards sperm are available, and counseling has been shown to be beneficial. It has been shown that infertile couples given counseling during assisted reproductive techniques had lower depression and anxiety scores, higher pregnancy rates, and more life satisfaction.

Physicians and mental health professionals should be more aware of these alternative antidepressants and the fertility problems associated with commonly prescribed antidepressants. Patients would also benefit from more visible access to counseling services during all stages of infertility diagnosis and treatment.

Board 19

ADRIAN PEKARCIK

Faculty Mentor: Mary McKenna
Howard University, Department of Biology through
University of Virginia's, Blandy Experimental Farm REU program.

Secondary compounds are produced by plants as a defense mechanism. It has been seen to increase the formation of root nodules in various legumes including *Medicago sativa* (Alfalfa) and *Vigna unguiculata* (Cowpea). Root nodules house nitrogen fixing bacteria *(Rhizobia)* which fix atmospheric nitrogen and give it to the host plant in return for sugars. This interaction could improve nitrogen content in the plants consequently affected overall growth and nutrient content in the plants.

FITNESS CONSEQUENCES OF THYMOL'S IMPACT ON NODULATION IN *MEDICAGO SATIVA* L. (FABACEAE) AND *VIGNA UNGUICULATA* (L.) WALP. (FABACEAE)

Production of secondary compounds by plants is one defense mechanism used in response to herbivory and plant-plant competition. These chemicals can also be beneficial to neighboring plants. Thymol, the main constituent of thyme-essential oil (TEO), produced from Studies by two previous REU students working with Mary McKenna have found that thymol and *Thymus spp.* increase root nodulation in *Medicago sativa* and *Vigna unguiculata*, both of the legume family (Ruiz, 2012, Rodriguez, 2011). This study evaluated growth, flowering, and insect response to thymol application in a field study of both species. We also conducted a greenhouse seedling study to examine nodulation and growth in *Vigna unguiculata*. Thymol was applied at two concentrations: Thymol 1=0.046ng thymol/in^3 soil volume, and Thymol 2 is a ten-fold increase (0.46 ng thymol/in^3). In *Medicago*, plants showed a strong nodulation response to thymol 1 with an average of twice as many root nodules as control and thymol 2 treatments. The Thymol 1 treatment also resulted in the greatest plant biomass ($p=0.040$) and root biomass ($p=0.014$). In *Vigna,* leaf production increased with the application of thymol treatments. In two surveys ($p=0.002$; $p=0.040$) we found the greatest leaf number/plant with Thymol 2, followed by Thymol 1. Control plants had the smallest leaf number/plant. In the greenhouse study, *Vigna* seedlings treated with thymol 1 and thymol 2 had greater root biomass than control ($p=0.003$), although we did not see a difference in the number of nodules/root. A survey of insect visitors on field plants of *Medicago* and *Vigna* shows a trend for fewer insects (herbivores and predators) on plants with thymol treatments. Leaf damage from herbivores was significantly decreased in *Vigna* plants treated with thymol ($p=.003$). This study has implications for improving plant nutrition and soil fertility in agroecosystems, and it adds to our understanding of the role of plant secondary compounds in mediating multi-species interactions in natural plant communities, particularly since mints (Lamiaceae) co-occur with legumes (Fabaceae) in many communities worldwide.

Board 20

RICHARD A. SCOTTEN

Faculty Mentor: Michael P. Carpenter
Argonne National Laboratory, Physics Division

A longstanding question in nuclear physics concerns the astrophysical birthplace of atoms heavier than iron. About 50% of these heavy elements like gold and uranium are assembled via the so-called rapid neutron capture process or *r-process*. Here, light nuclei are pumped full of neutrons on the order of seconds, and the debate is whether the r-process occurs in supernovae (exploding stars) or merging binary neutron stars, or both. To answer this, we need to understand how the r-process works, and this research seeks to provide experimental data to help describe it.

DISTRIBUTION OF LOG *FT* VALUES FOR ^{144}BA

The partial level structure of neutron-rich ^{144}Ba was deduced following the ß- decay of ^{144}Cs. The number of known levels has been greatly expanded, and states with spins ≤5 □ have been observed. The isotope was produced using a re-accelerated beam of ^{144}Cs extracted from CARIBU, and implanted in a Pb foil placed at the target position of the Gammasphere array. The comparative ß decay half-life, log *ft*, has been classified according to the degree of forbiddenness for 55 energy levels, corresponding to 136 total transitions. For the 37 transitions feeding the first 2+ state in ^{144}Ba, a log *ft* result of 5.83(4) is reported, which favors a positive parity assignment for the ^{144}Cs spin-1 groundstate. The current status of the research will be discussed, including the angular correlation measurements used to infer the spin and parity assignments of the newly reported energy levels, and if evidence of multi-phonon states, specifically double octupole phonon states was observed.

Board 21

JENNA E. REEGER

Faculty Mentor: Maureen Hanson
Boyce Thompson Institute for Plant Research, Cornell University,
Department of Molecular Biology and Genetics

Most cyanobacteria contain structures, called carboxysomes, that allow the bacteria to photosynthesize more efficiently. If carboxysomes could be formed inside crop plant cells, the plants may be able to grow more efficiently and increase their yields. My project focused on some of the proteins that make up the carboxysome and looked at how they assemble with each other when they are inside plant chloroplasts. Learning more about these carboxysome proteins will hopefully allow us to construct the full carboxysome in plant cells in the future.

TRANSIENT EXPRESSION OF CYANOBACTERIAL ß-CARBOXYSOME PROTEINS IN NICOTIANA TO STUDY PROTEIN ASSEMBLY

ß-carboxysomes, a type of microcompartment present in most photosynthetic cyanobacteria, concentrates CO2 near Rubisco inside a protein shell to improve carbon fixation in photosynthesis. Incorporation of ß-carboxysomes into C_3 crop plants could potentially improve their photosynthetic efficiency and increase their overall yield. Approximately ten types of proteins are proposed to form the full carboxysome, but little is known about their individual structures and roles in carboxysome function. This study focused on possible assemblies formed by various carboxysomal proteins when expressed within tobacco chloroplasts. Carboxysomal shell proteins, CcmP, CcmO, and CcmK2, and interior protein CcmM35 were fluorescently tagged and attached to a chloroplast transit peptide using overlap extension PCR, and the gene inserts were ligated into vectors for *E. coli* transformation. Agrobacteria were then transformed with the vector constructs, and the genes were transiently expressed in *Nicotiana tabacum* and *N. benthamiana* using agroinfiltration. The leaf tissues were imaged using confocal microscopy to determine the proteins' distribution within the chloroplast. A diffuse fluorescent signal, spread over the entire chloroplast, gives evidence that a protein is not involved in the assembly of macromolecular complexes with other proteins. Presence of punctate signals suggests that a transiently expressed protein possibly associates with other proteins to form a significant assembly. Further understanding of the assembly of carboxysomal proteins is helpful for eventually attaining full carboxysome construction within plant chloroplasts.

Board 22

CASEY SMILEY

Faculty Mentor: Herbert L. DuPont
The University of Texas Health Science Center at Houston
Center for Infectious Diseases

This study is important because of the rising importance of *Clostridium difficile* associated diarrhea (CDAD) in the hospital setting and the inaccuracy of current diagnostic methods. Currently, the method for diagnosing this infection is polymerase chain reaction (PCR) which cannot differentiate between infection without symptoms and disease with false positive tests leading to administration of harsh and expensive antibiotics when they are not needed. In this study the white cell product calprotectin was shown to allow the diagnosis of inflammatory and treatable CDAD and finding the inflammatory marker predicted more severe CDAD and patients more likely to develop recurrent illness.

ROLE OF CALPROTECTIN AS A MARKER FOR DIAGNOSIS AND SEVERITY OF *CLOSTRIDIUM DIFFICILE* ASSOCIATED DIARRHEA (CDAD)

Clostridium difficile is an increasing cause of healthcare-associated diarrhea (HAD) and death with high rates of recurrence after treatment. The organism commonly colonizes hospital patients without producing symptoms. Currently, CDAD is diagnosed using qPCR because of high test sensitivity. False positives arise as this method detects genes of toxigenicity, not functional toxins, and does not distinguish between colonization and disease. To compound problems of diagnosis, CDAD is only found in 10% of HAD cases. The objective of this study was to investigate the neutrophil inflammation marker calprotectin as a potential biomarker for both CDAD presence and severity. We hypothesized that because *C. difficile* toxins A and B in patients with CDAD produce mucosal inflammation, levels of fecal calprotectin would be higher in patients with CDAD. Severity of CDAD was based by white blood cell count level and temperature. Testing of fecal calprotectin was performed by enzyme-linked immunosorbent assays (ELISA). Fecal calprotectin concentration was measured from 150 patients classified as severe (N=50) or non-severe (N=50) CDAD, or *C. difficile*-negative HAD (N=50). Levels of calprotectin highly correlated with severity and presence of CDI, with median values of 275.72 µg/ml, 11.25 µg/ml and 15.74 µg/ml for severe CDAD, non-severe CDAD and HAV groups, respectively. Fecal calprotectin levels also were higher in subjects who later recurred with CDAD. The study provides evidence that calprotectin is an effective diagnostic and prognostic marker in CDAD.

Board 23

MARY ANN LEE

Faculty Mentor: T. Aran Mooney
Woods Hole Oceanographic Institution, Department of Biology

Carbon dioxide in the atmosphere dissolves into the ocean, driving CO_2 hydrolysis and decrease in sea water pH. Squids are affected by decreased carbonate levels in the water because they are building their statoliths, gravity and movement sensors, with a mineral form of calcium carbonate. This study investigated the effects of increased carbon dioxide in the water on paralarval squid swimming behavior. Decreased swimming capabilities resulting from ocean acidificiation can significantly influence paralarval survival, therefore it is crucial to understand the impacts of increased carbon dioxide in sea water.

EFFECTS OF OCEAN ACIDIFICATION ON THE SWIMMING BEHAVIOR OF PARALARVAL LONGFIN INSHORE SQUID *(DORYTEUTHIS PEALEII)*

Ocean acidification, anthropogenic atmospheric CO_2 dissolving into the ocean, leads to lower levels of pH in sea water. The subsequent decrease of carbonate ions can be problematic for marine organisms using calcium carbonate to build skeletons and other physiological structures. *Doryteuthis pealeii,* the longfin inshore squid, is abundant along the Atlantic coast and an essential component of the pelagic food web. During ontogeny, squid lay down aragonite to build their statoliths: gravity and movement sensors vital to swimming. In this study, *D. pealeii* were raised and hatched in elevated levels of CO_2 to understand the potential impacts of ocean acidification on paralarval swimming behavior. A CO_2 flow-through equilibration system was used, with ambient sea water bubbled with CO_2 air mixes and resulting in equilibration to 600, 1300, and 2200 ppm CO_2 levels. Squid paralarvae hatched from the different levels of pCO_2 were filmed to record swimming behavior. Afterwards, paralarvae statoliths were extracted and imaged with a scanning electron microscope. Three distinct swimming patterns were observed: bobbers, spinners, and vertical spinners. Average, maximum, and minimum speed, distance traveled, and average turning angle were analyzed for each individual using a MATLAB tracking code. Average swimming speed was significantly higher in the spinner types. Since no apparent pattern between abundance of spinners and CO_2 exposure could be identified, these were considered aberrant, and only bobbers were analyzed further. Average speed and total distance traveled were about equivalent in the 600 and 1300 levels but lower in the 2200 ppm level. Statolith analyses revealed that statoliths from 2200 ppm were highly damaged compared to those from the 600 and 1300 ppm levels. Ocean acidification, resulting in lowered swimming speeds, can affect paralarval dispersal, predator avoidance, and prey capture abilities, which could have a substantial impact on their survival.

Board 24

WEN YU (AMY) WONG

Faculty Mentor: Joseph Loftus
Mayo Graduate School, Department of Biochemistry and Molecular Biology

Patients diagnosed with glioblastoma (the most aggressive primary brain tumor) usually have an average survival rate of 15 months after diagnosis. One reason for this poor outcome is the ability for the tumor cells to migrate and invade into neighboring cells. My research this summer focuses on TROY, a receptor that is known to regulate cell invasion, and how it promotes downstream signals. By understanding what regions of TROY are essential for activation and promotion of pro-migratory effects, we can then identify specific pathways that TROY regulates and create therapetuic drugs to target TROY signaling.

CHARACTERIZATION OF TNFRSF19 (TROY) SIGNALING

Glioblastoma multiforme (GBM) is the most common & aggressive form of primary brain tumors in adults and has been difficult to treat, as invasion makes complete resection impossible & promotes chemotherapeutic resistance. Thus, there is a need to identify genes that act as invasive drivers. TROY (TNFRSF19), an orphan member of the TNFR superfamily, has been reported to have a role in regulating glioma invasion. While TROY signaling presents a potential therapeutic target, the mechanism is unknown. The purpose of this research is to 1) identify residues/domains within TROY that are essential for invasion, 2) devise a method to initiate TROY signaling in the absence of a ligand, and 3) correlate TROY signaling with glioma cell invasion. TROY's cytoplasmic domain (TROYcd) have 2 potential signaling domains; the membrane proximal domain (MPD) and a TNF Receptor Associating Factor (TRAF) binding domain (BD). Since TROY's ligand is unknown, latent membrane protein 1 (LMP1) was used to constitutively promote oligermization of TROY. Full-length TROY variants containing ΔMPD or a TRAF BD mutation and LMP1-TROYcd chimera variants were created & tested for their capacity to activate NF-kB after transfection into a luciferase reporter cell line. Initial results suggest that both the MPD and TRAF domains are crucial for NF-kB activation by TROY. But surprisingly, ΔMPD doesn't seem to affect signaling when the proteins oligermizes. Correlation of TROY signaling to its function was studied through rescue experiments using T98G glioma cells in which TROY was stably knocked down (KD) by shRNA. Variants protected against the shRNA were created, transfected into the KD cells, & expression verified by Western Blot. The long-term goal of this project is to validate the therapeutic potential of targeting TROY signaling. This could improve the treatment of GBM by specifically targeting invasive drivers, reducing cell dispersion, and increasing susceptibility to chemotherapeutic agents.

Board 25

CARA DEANGELIS

Faculty Mentors: Matt Oremland and Reinhard Laubenbacher
Virginia Bioinformatics Institute, Department of Mathematics

Agent based models (ABMs) are computer simulations that demonstrate behaviors among agents, or entities, and their given environment. Our overall goal was to represent an ABM, specifically one known as SugarScape, with a set of equations so that solutions to a posed optimization problem could be found quickly through the equations. The specific optimization problem involved finding tax schedules that maximized the amount of wealth acquired while minimizing the number of deaths caused by taxation.

DIFFERENCE EQUATION APPROXIMATIONS OF AGENT BASED MODELS FOR SOLVING OPTIMIZATION PROBLEMS

Agent based models (ABMs) are a type of simulation model in which individual agents interact with each other and their environment according to defined rules. While ABMs are a powerful tool for investigating emergent behaviors of interacting agents, they are often computationally intensive and suffer from a lack of mathematical analytical tools. Conversely, mathematical modeling approaches are analytically tractable, but their construction requires high level knowledge of the system to be modeled. We developed a method of capturing the benefits of both modeling paradigms by constructing a system of equations that describes the high level behavior of an agent based model known as SugarScape. In order to test the problem-solving efficacy of this approach, we posed a multi-objective optimization problem in the SugarScape agent based model and found a solution through the equation model. Specifically, our problem was to find an optimal sugar tax schedule that minimizes deaths while maximizing the sugar collected. The system of difference equations was derived analytically and computationally to describe the movement of the ants, their sugar accumulation, and their population size. The optimal tax schedules, discovered through the system of equations, were compared with those from the original agent based model in order to determine the descriptive effectiveness of the mathematical model.

Board 26

KRISTIE GOUGHENOUR

Faculty Mentor: Qiang He
University of Tennessee, Department of Civil and Environmental Engineering

Tap water quality is a source of concern for public health. This project investigates the occurrence of the genus *Mycobacterium* and the genus *Legionella* in tap water differentiating between stagnant and fresh water and old and new buildings. This will help provide a better picture of contamination in tap water and help identify areas of greatest concern.

BACTERIA IN TAP WATER: A qPCR APPROACH TO QUANTIFYING POTENTIAL PATHOGENS

Bacterial contamination of tap water is a growing concern in water quality, particularly the genus *Mycobacterium* and the genus *Legionella* both of which contain pathogens. This study attempted to quantify bacterial amounts in stagnant and fresh water using qPCR analysis for the *Mycobacterium* genus and the *Legionella* genus while investigating potential causes of variations in bacterial counts including building age, free chlorine levels, total organic carbon (TOC) and selected ion levels. Fresh and stagnant water samples were taken and chlorine levels were obtained. The water samples were filtered and filtrate was collected for TOC and ion analysis. DNA was extracted from the filters and qPCR analysis was performed. *Mycobacterium* levels are significantly higher in stagnant water, while *Legionella* show no significant differences. The age of the building does not show a significant effect on bacterial levels. TOC and selected ion concentrations do not appear to vary in stagnant and fresh water or old and new buildings

Board 27

MICHELLE STORMS

Faculty Mentor: Rajiv Singh
University of California, Davis, Department of Physics

When two particles are quantum entangled, they are correlated such that the properties of one particle depend on the other, and vice versa. While physicists often study small systems of two or three entangled particles, my project involves the entanglement of large numbers of particles arranged in a repeating lattice pattern. I calculate the entanglement entropy of the system, which can be thought of as a measure of how much entanglement exists between, for example, the left and right halves of the lattice. Several variations on this simple lattice are being explored to determine their effects on the value of the entanglement entropy, and to determine the relationship between entanglement entropy and thermodynamic entropy.

ALCULATION OF ENTANGLEMENT ENTROPY IN FERMION LATTICES

Quantum entanglement is a relatively recent discovery in physics with applications in encryption and information storage. Entanglement can be quantified by calculating the entanglement entropy of the system, which measures the amount of information lost as a result of the quantum correlations between the particles in the system. The present study focuses on the entanglement entropy between two halves of a many-body system. The model used in this study allows for the movement of electrons between atomic orbitals in a lattice of periodically-arranged atoms. This movement is governed by a transfer integral t. A staggered chemical potential μ is added to create a gap in the electronic energy spectrum. The effects of several different arrangements of transfer integrals and chemical potentials were determined for the ground state system. The entanglement entropy for the ground state system in one, two, and three dimensions was found to vary according to an "area law," i.e. proportionally to the area of the boundary separating the two regions. For an excited state, the entropy was determined to be proportional instead to the volume of the system. Furthermore, the entanglement entropy at finite temperature was found to be closely related to the thermodynamic entropy of the system.

Board 28

ASHLEY TAYLOR AND ERIKA KAZI

Faculty Mentor: David Johnson
Ohio Wesleyan University, Department of Botany and Microbiology

This project looked at modern agricultural practices and development of alternative, sustainable techniques in the equatorial, coastal rainforest of Ecuador. By practicing permaculture (architecture of human settlements and agricultural practices modeled from natural ecosystems) with the Third Millenium Alliance program we engaged in real world sustainability efforts. As interns, we developed methods for food production and simple living that helped to preserve the surrounding environment. With the combination of our academic and empirical knowledge, we hoped to engage in the further development of a more sustainable Ohio Wesleyan and hopefully with a more sustainable world. The practical knowledge that we will gain with this project will allow us to be the opposite of ordinary.

ENVIRONMENT, PERMACULTURE, AND SUSTAINABILITY IN ECUADOR

Our main objectives for this proposed project included, and are not limited to, the following: (1) researching and gaining a better understanding for the ecology of the tropical rain forest region, (2) obtaining and conveying sustainable living and permaculture farming techniques, methods, and benefits in order to help create a more sustainable OWU, and (3) studying and experiencing the cultural composition and assisting in the sustainability practices of a developing country. Some important outcomes we received from this project include: ecological research experience, social and cultural involvement, new sustainable practices, building upon the aspirations of the Jama-Coaque Reserve, and projecting the importance of preservation and research in the highly productive area to the school community.

By immersing ourselves in innovative and sustainable permaculture practices, our trip to Ecuador provided us with a pedagogical experience that we can apply to the school community, our daily lives and the remainder of our studies at Ohio Wesleyan. We hope to present tangible evidence in the form of a documentary to express what we have learned through our research and our new found experience to impact the OWU community.


EG&G ORTEC

The NSF-funded REU/RET (Research Experience for Undergraduates/Teachers) program at Ohio Wesleyan makes it possible for students from universities across the country, as well as one or two high-school science teachers from central Ohio, to do research in the fields of astronomy, computer science, mathematics, and physics on the OWU campus.

Board 29

BEN LETSON,
OHIO WESLEYAN UNIVERSITY

Faculty Mentor: Craig Jackson
Department of Mathematics

String links are basically what happens to the cords that run to and from your TV: a string link is a collection of strands that cross and loop around each other. Just like knotted cables, string links can be very complicated and difficult to express in simplest terms, but we can create mathematical tools to aid our understanding of them. In this case, that tool is a *representation*, which is an exact way to assign a matrix of numbers to each string link. This summer we worked to show that two seemingly different representations are, in fact, exactly the same.

REPRESENTATIONS OF STRING LINKS

String links are collections of knotted strands with an equal number of fixed beginnings and ends. The set of string links forms a monoid under concatenation and generalizes the Artin braid group. By mapping the set of string links to the space of square matrices, via a homomorphism, we attain a representation. The representation of braid groups has been studied extensively, due to the relation between braids and knot theory. However the representation of string links remains largely unexplored.

We present two representations of the string link monoid: one introduced by X.S. Lin which is calculated by considering paths along string links and another derived from the Conway skein relation which allows string links to be reduced to linear sums of braids. Both of these representations reduce to the well-known Burau representation when evaluated on braids.

We show that both representations are equivalent on three infinite families of string links. Further, we investigate the behavior of both representations on the subset of independent string links (those which contain strands that only cross themselves). These calculations support the conjecture that the representations are equivalent in general and we provide methods by which this may be proven. In particular, we produce a skein relation involving the Lin representation that implies the conjecture and reduce this relation to a relation on Lin diagrams.

Board 30

BRENDAN COLE,
WESLEYAN UNIVERSITY;

JOSH DENISON,
OHIO WESLEYAN UNIVERSITY;

KATIE GRAY,
WHITMAN COLLEGE

Faculty Mentor: Robert Harmon
Department of Physics and Astronomy

Starspots are darker regions on a star that are cooler than the rest of the surface due to strong magnetic fields that inhibit heat transport into them. Images of a star can be processed to determine the brightness of the star, which will change as starspots are carried into and out of our view by the star's rotation. We made plots of the star LO Pegasi's varying brightness over time, called light curves, and used them to study the spots on its surface this summer and compared them to results from 2006-2012.

STARSPOTS ON LO PEGASI, 2006-2013

Starspots are cooler areas of the stellar surface due to strong perpendicular magnetic fields which restrict convective heat transport. Because of the link between starspots and magnetic activity, the study of starspots sheds light on the workings of stellar magnetic dynamos. LO Pegasi has a short (10.153 hr) rotational period, has previously been observed to exhibit spot activity, and is well placed for observation during the summer months. Images through standard B, V, R and I photometric filters were collected via a 0.3-m Schmidt-Cassegrain telescope and a CCD camera, and then differential aperture photometry was performed to produce light curves for each filter. Variations in the star's brightness and color as the spots were carried into and out of view of Earth by the star's rotation were used to infer present properties of the spots and to compare our results to those obtained from 2006-12.

Board 31

ANGELA GAETANO,
BELMONT UNIVERSITY

Faculty Mentor: Scott Linder
Department of Mathematics and Computer Science

In many applications, data used for inference are subjected to censoring. In Type II censoring, the researcher decides a priori how many (p) of the original n observations are to be made. For example, we might begin an experiment with 100 light bulbs, but only wait for 10 of them to burn out. Using R statistical software, we use simulation to approximate the mathematically intractable sampling distribution of the least-squares estimator of slope in a simple linear regression model. We focus in particular on the variance of this estimator, and on power of the standard t-test typically applied in inference for this parameter.

IMPACT OF CENSORING ON ESTIMATOR OF SLOPE PARAMETER IN A SIMPLE REGRESSION MODEL

When a random sample taken from a bivariate Normal population is subjected to Type II censoring on one of its variates, the sampling distributions of statistics associated with simple linear regression estimators are typically mathematically intractable because the censoring mechanism induces a complex dependence structure between observations. We examine here the sampling distribution of the least-squares estimator of slope in a simple linear regression model. Using simulation, we measure the variance of this estimator (which has no closed form) under different experimental conditions, and we construct a model useful for estimating this variance from those conditions. Next, we consider the power of the standard t-test for independence in a simple linear regression model. Again, using simulation, we compute power and construct a model for it based on experimental conditions. The model allows prospective researchers to determine various combinations of experimental conditions (original sample size and degree of censoring) that obtain specified power.

Board 32

SYLVIA MORROW,
HOUGHTON COLLEGE

Faculty Mentor: Robert Haring-Kaye
Department of Physics and Astronomy

Many atomic nuclei have spherical shapes. Shapes that depart from sphericity usually resemble either an Amerian football or a Frisbee. Such shapes are symmetric about at least one of the three spatial coordinate axes. Only very rarely do nuclear shapes become rigidly triaxial at low energy, where the shape is completely asymmetric about each of the three spatial coordinate axes. Recently, a rigid triaxial shape was discovered in the ^{76}Ge nucleus. The goal of this work was to search for such a shape in ^{70}Ge. In the end, we concluded that ^{70}Ge is not triaxial but rather is nearly spherical.

SEARCHING FOR RIGID TRIAXIAL DEFORMATION IN ^{70}GE

The shapes of atomic nuclei, being too small for direct observation, can be inferred in part from the energy relationships among observed excited states. The γ vibrational band is of particular interest as it can be an indication of the presence of rare nuclear shapes at low energies such as rigid triaxial deformation, a structure recently observed in ^{76}Ge. The mass A=70 region of the nuclear landscape is considered fertile hunting ground for further incidences of rigid triaxial deformation as well as other exotic structures exhibiting tetrahedral symmetry (pyramid-like shapes) which, so far, exist only in theory. The goal of this work was to search for such exotic shapes in ^{70}Ge. Excited states in ^{70}Ge were populated by an experiment done at Florida State University's John D. Fox Superconducting Accelerator Laboratory involving a 50 MeV 18O beam impinging on a ^{55}Mn target. This reaction produced high-spin states in ^{70}Ge which then relaxed to its ground state by emitting cascades of gamma rays. Analysis of coincidence relationships in the gamma radiation detected by the 10 high-purity germanium detectors surrounding the target allowed for improvements to be made in the ^{70}Ge level scheme. Most significantly, a previous ^{70}Ge level scheme showed the possible foundation of a γ vibrational band in ^{70}Ge, and this study extended this band enough to perform an analysis of the associated structure of ^{70}Ge. Analysis of the staggering parameter S(I), Total Routhian Surfaces calculations, and the kinematic moment of inertia compared to nearby germanium isotopes all indicate that ^{70}Ge is acutely γ soft and can be described reasonably well at low spin by vibrations of a nearly spherical shape.

Board 33

ONYEBUCHI EKENTA,
WASHINGTON AND LEE

Faculty Mentor: Craig Jackson
Department of Mathematics and
Computer Science

The braid group is a type of mathematical object involving braided strands. They can be represented with matrices. In this project, we nd a correspondence between two types of braid group representations.

BRAID GROUP REPRESENTATIONS

In 2001, Stephen Bigelow showed that the braid groups B_n are linear by nding a faithful representation of B_n on the second homology module $H_2(\tilde{C}_{n,2})$. The space $\tilde{C}_{n,2}$ is constructed as a regular covering space of the conguration space $C_{n,2}$ of all unordered pairs of distinct points in an n-punctured disk and the braid generators act on this space as Dehn twists. This representation is one of a family of homological representations discovered by Ruth Lawrence in 1990. Bigelow's paper, along with Daan Krammer's article in which he independently proved the same result, lead to renewed interest in braid group representations. However, the braid representations arising from the full family of homology modules $H_\ell(\tilde{C}_{n,\ell})$ ($\ell > 2$) have remained mostly unexplored.

In 2011 Jackson and Kerler demonstrated that the homological braid representation on $H_2(\tilde{C}_{n,2})$ is isomorphic to the representation of B_n arising from the action of a universal R-matrix on a highest weight space $W_{n,2}$ of the generic Verma module $V^{\otimes n}$ of the quantum group $U_q(\mathfrak{sl}_2)$. They further conjectured that $H_2(\tilde{C}_{n,2})$ is isomorphic to $W_{n,\ell}$ for all $\ell \geq 0$. This result provided an intriguing connection between the homological representations of Lawrence and others and the vast families of braid group representations constructed from quantum algebras and conformal eld theories.

Recently, Ito (using theories developed by Khono) gave a proof demonstrating the conjectured isomorphism $H_{n,\ell} \cong W_{n,\ell}$. However, an analysis of Ito's isomorphism at the basis level seems to indicate that braid action is not be preserved under the mapping. In particular, we identify scenarios in which a braid acts trivially on an element of $W_{n,\ell}$ whereas the action on the corresponding element of $H_{n,\ell}$ is non-trivial.

In this project, we propose a new fork basis for which the resulting representation of the braid action on the homology module $H_{n,\ell}$ will correspond (up to an identication of parameters) to the basis chosen by Ito for the quantum representation $W_{n,\ell}$. This approach has the benet of establishing the isomorphism $H_{n,\ell} \cong W_{n,\ell}$ using elementary methods and without reliance on complicated machinery.

Board 34

MICHAEL LEONE,
NEW COLLEGE OF FLORIDA

Faculty Mentor: C.G. Fink
Department of Physics and Astronomy

Neurons form complex networks in the brain, where they communicate with each other by firing action potentials. The synchrony of neuronal firing is associated with many important mental functions, like memory formation and selective attention, as well as many dysfunctions, such as autism and epilepsy. Using computer simulations, we investigated the factors which determine neuronal synchrony by exploring the interplay between network structure and individual cellular characteristics. We were particularly interested in how different kinds of cells affected synchrony when they were highly connected.

SYNCHRONIZATION OF NEURONAL NETWORKS WITH HETEROGENEOUS EXCITABILITY TYPE

Two main factors determine the degree of neuronal synchrony: network connectivity structure and individual cellular characteristics. One important cellular characteristic is neuronal excitability type, which describes how neurons transition to firing. In general, networks with so-called Type II excitable neurons are known to synchronize better than networks with Type I neurons. Little is known about mixed-type networks, however. In order to investigate the interplay between network topology and excitability type in mixed networks, we compared two connectivity paradigms: 1) small-world networks, which interpolate between lattice-like and random networks, and 2) scale-free networks, which feature a population of highly-connected hub cells. Starting with a Type I network, it was expected that synchrony would increase as Type II neurons were added, but the details turned out to depend upon the connectivity paradigm. In mixed scale-free excitatory networks, synchrony increased with the inclusion of more Type II neurons, and selecting Type II neurons as the highly connected hub cells enhanced synchrony most dramatically. Small-world networks, on the other hand, required more than 50% Type II neurons in order to achieve the same synchrony as a scale-free network with only 20% Type II hub neurons. These results support previous findings that scale-free networks are prone to excessive network synchrony, and specifically implicate Type II hub cells as the most effective promoters of such synchrony.

HALEIGH WRIGHT,
UNIVERSITY OF PITTSBURGH

Faculty Mentor: Sean McCulloch
Department of Math and Computer Science

Battle Line is a 2-player card game, played with a deck composed of 6 colors; each having values 1-10. Players attempt to complete 3-card poker hands on each of their 9 flags. Players compete to claim flags by having a better hand than their opponent on the same flag. We have developed a program that enforces the rules for any combination of two players (person v. computer, person v. person) and subsequently developed an Artificially Intelligent computer player for this game by implementing a weighted sum model that computes the weighted sum of several attributes. These attributes consist of the power of a card (and the hands it could potentially yield), the risk associated with playing that card on that flag (how much the move will negatively affect possible hands on other flags), and the actual completeness of the hand (how many cards needed for the hand do we already have). These attributes are weighted by their relative importance in winning hands. A weighted sum is computed for each of the 63 possible moves (7 cards on 9 flags), and the best score, which indicates the best move, is executed.

Graduation with Honors in Scholarship 2012–2013

Graduation with Honors in Scholarship requires an independent project, an oral exam on the project, and a comprehensive exam in the student's major department during his or her senior year. The program is open to students who have attained cumulative grade point averages of 3.5 in their majors after fall semester of the junior year, as well as overall grade point averages of 3.0 or the support of their academic major departments, and have successfully petitioned the Ohio Wesleyan Academic Policy Committee.

Student Name	Department	Supervising Professor	Title
Megan Cook	Psychology	DiLillo	Physiological and Psychosocial Effects of the Inclusiveness of Physicians' Language on Heterosexual and Queer College Women
Ellen Defenderfer	Psychology	Bunnell	Posttraumatic Growth, Coping Strategies, and Empathy in College Students
Clarice Edwards	Neuroscience	Yates	Effects of Voluntary Exercise on Neuroplasticity Following Traumatic Brain Injury
Kassel Galaty	History	Spall	"The Infected Man Has Been Altogether Lost Sight Of" Dr. William Budd, the Importance of Epidemiology, And the Propagation of Germ Theory
Nurul Islam	Physics	Haring-Kaye	Selective Population and Decay of Neutron-Unbound States in ^{24}O
Sidney Kochman	Humanities/Classics	Lateiner	Women's Sexual Agency in Fifth Century Athens and the *Nomos Moikheiās*
Kaitlin Lentz	Sociology/Anthropology	Durst	Teen Motherhood: Symptom of Structural Epidemic
Anni Liu	English	Caplan	Poems
Sriharsha Masabathula	Economics	Gitter	Comparative Analysis of Healthcare in Developing Nations
Lydia Mortensen	Education	McClure	Effects of Schools, Policies, and Legislation on the Achievement of Low SES Young Children
Danielle Muzina	BFA Studio Art	Bogdanov	Silent Conversations: Drawings and Paintings
Zijie Poh	Physics	Trees	Phase Dynamics in Josephson Junction Arrays
Riane Ramsey	Psychology	Bunnell	Dance Class Intervention for Down Syndrome
Paige Ruppel	Botany/Microbiology	Anderson	A multi-site comparison of *Alliaria petiolata* (garlic mustard) invasion success in urban and rural environments
Devinn Sinnott	Zoology	Panhuis	Characterization of the Alpha-2 macroglobulin (A2M) gene in the *Poeciliopsis* fish placenta
Brittany Vickers	Journalism	Rhodes	Health and Wellness Magazines and Female College Students
Colleen Waickman	WGS/SOAN	Cohen/Schrock	A Cross-Cultural and Qualitative Analysis of Women's Access to Scientific Fields in the Netherlands, Czech Republic, Poland and United States Midwest
Guanyi Yang	Economics	Rahman	The Impact of International Aid to Sub-Saharan African Regional Economy

Here are some of the things past SSRP participants are doing now.

2011 SSRP PARTICIPANTS

ALAN MASSOUH '13
Applying for medical schools at the beginning of the summer. Currently volunteering at the Native American Alliance clinic in Helena, MT

ZIJIE POH '13
Attending graduate school to earn a PhD in Physics at The Ohio State University

2012 SSRP PARTICIPANTS

TYLER SHEETZ '13
Attending medical school, perhaps Temple or Ohio State

CHARLES BRECHTEL '13
Masters degree in Aerospace Engineering at CU Boulder

MARY ANN (JUNG HYUN) LEE '14
Summer REU research project at Woods Hole Oceanographic Institution

ELLEN DEFENDERFER '13
Clinical psychology PhD program at University of Wisconsin in Milwaukee

JENNIFER WALLACE '14
Internship with the Ohio Wildlife Hospital

SARAH WELLS '13
Volunteering/observing at West Chester Medical Center (a branch of University of Cincinnati Health) for physical therapy to complete needed hours in order to apply for a graduate physical therapy program in the fall

CLARICE EDWARDS '13
Attending University of Pittsburgh in the fall (likely August) for its doctoral neuroscience program.

CHELSEA DENNIS '13
Molecular Biologist at Astrix Technology Group

RACHEL THOMAS '14
2013 Summer Internship Course at the Cleveland Clinic's Center for Reproductive Medicine

IFTEKHAR SHOWPNIL '13
Looking for a job as a lab assistant

BRITTANY LUTZ '13
Internship at the Oregon Coast Aquarium with the marine mammal department in Newport, OR

RIANE RAMSEY '13
Applying for research assistant jobs in psychology and gaining research experience before applying to graduate school for clinical psychology

PAIGE RUPPEL '13
Heading to northern Wisconsin to work as a research intern for the forest landscape ecology lab at University of Wisconsin-Madison. Working on the Flambeau Project, a long-term study on how second-growth forest structure manipulation influences functional dynamics. Responsible for assisting with field data collection and management

CAMPUS AND OFF-CAMPUS RESEARCHERS

NSF-REU/RET RESEARCHERS

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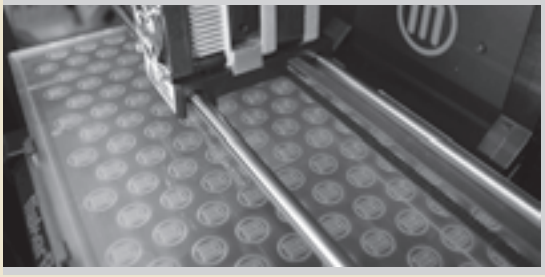
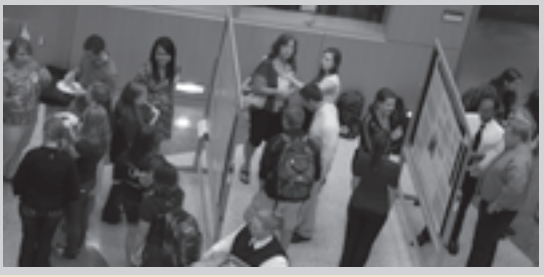
OWU/Aramark Housekeeping staff
Chartwells Dining Services
Office of Marketing and Communications
Faculty supervisors and student volunteers
Parents and guardians of student researchers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