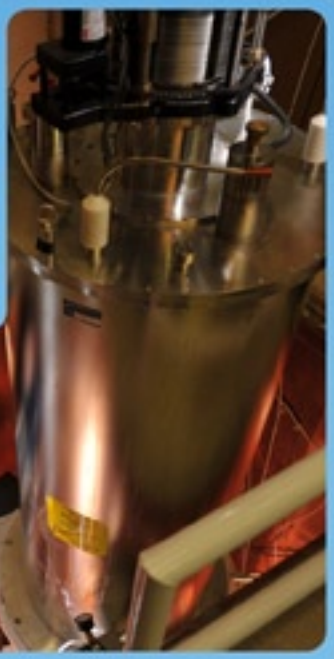
Notre Dame Science
Research Fair and Information Night

Fall Undergraduate Research Symposium
Schedule and Abstract Book







COLLEGE OF SCIENCE
FALL UNDERGRADUATE RESEARCH SYMPOSIUM

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8:00 - 9:00 p.m.
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ORAL PRESENTATIONS I

Magnetic Vortex Properties of the MgB_2 Superconductor

Tommy O'Brien
Major: Physics
Advisor: Morten Eskildsen, Department of Physics

Magnesium diboride (MgB_2) is a well-known superconductor and is often considered to be the paradigm for Type II superconductivity. The main purpose of this paper is to present results on the exploration of some of the magnetic vortex properties of this superconductor, including its metastable magnetic phases and magnetic phase diagram. Focus will be on the existence of vortex configurations that are stable only under certain conditions, namely a field cool transition into the superconducting vortex state. The differences in field cool and zero field cool will be explored, including their impact on vortex lattice configuration. The existence of these metastable states is shown by inducing by an applied field "wiggle", or oscillation, in which the metastable configuration is forced into a more stable state. The results shown in this presentation were obtained during a Small Angle Neutron Scattering (SANS) experiment conducted at the Institut Laue Langevin in Grenoble, France, in June of 2009.

What inspired you to participate in undergraduate research?

Not only am I intrigued by superconductors, but I love working with complicated machinery and couldn't resist the opportunity to help with an experiment overseas.

How did you get your research position, and what preparation did you undertake for it?

The College of Science Undergraduate Research Fellowship at the University of Notre Dame funded my summer research along with the Glynn Family Honors Program and the Notre Dame REU. This summer research is only part of the research on which I will be writing my undergraduate thesis.

Where was your research experience located?

University of Notre Dame

What did you get out of your research experience?

I spent a wonderful summer at Notre Dame and met new friends as well as learning how to conduct an experiment, work with Small Angle Neutron Scattering equipment, and how to present my results.

ORAL PRESENTATIONS I

The Effects of Sex Ratio on the Reproductive Output of the Florida Apple Snail

Maggie McQuillan
Major: Environmental Science
Mentor: Amber Garr and Helen Lopez,
Harbor Branch Oceanographic Institute, Florida Atlantic University

The Florida apple snail has been cultured at Harbor Branch Oceanographic Institute at Florida Atlantic University since August of 2007 for stock enhancement purposes. It is part of an effort to increase the population of the federally endangered bird, the snail kite, which relies almost entirely on the apple snail for food. To improve culturing methods at Harbor Branch, the effect of sex ratio on the reproductive output of adult snails was studied. An increase in reproductive output would help to increase the number of snails released in south Florida. However, to set up the sex ratio study, a simple way to identify males and females first had to be established. This was done by testing six chemicals to try to induce relaxation in the snails so their sex organs could be viewed. The results of this study revealed that benzocaine mixed in methanol was most effective at inducing relaxation. This relaxation methodology was used to set up the sex ratio study that tested the ratios 5F:5M, 7F:3M, 8F:2M, and 3F:7M. The study was conducted for eight weeks. No significant differences were found in the number of eggs produced per female between any of the ratios or in the number of egg clutches produced for each ratio. Although not significant, trends showed at least a 1:1 sex ratio is needed to produce enough juveniles to sustain commercial production. Snails from treatments with an equal or greater number of females in each tank produced up to three times the number of hatched juveniles than the treatment with more males.

What inspired you to participate in undergraduate research?
I love learning about the ocean, so I really wanted to participate in a program that allowed me to do this. I found Harbor Branch's internship program that was a perfect fit with my background in science.

How did you get your research position, and what preparation did you undertake for it?
I learned about the internship from an advertisement one of my professors gave me. I applied for the program directly through Harbor Branch and after I was accepted into the program, I began conversation with my mentor about possible projects.

Where was your research experience located?
Harbor Branch Oceanographic Institute at Florida Atlantic University in Fort Pierce, Florida

What did you get out of your research experience?
I was able to apply what I learned at Notre Dame in a real world situation and also gained new experience conducting an independent research project.

ORAL PRESENTATIONS I

Curcumin inhibits ENU-induced mammary gland tumors in APCMin mice: Modulation of inflammatory cytokines

Ted Lee
Major: Science Pre-professional Studies and Anthropology
Advisor: Meena Katdare,
Cell and Developmental Biology in Surgery, Weill Cornell Medical College

Breast cancer is the second most common cause of cancer death and most diagnosed cancer in US women. The immune system and inflammation strongly affect breast tumor proliferation. While anti-inflammatory cells may fight cancer in the healthy body, chronic inflammation may lead to cancer development. Tumor cells often induce pro-inflammatory cells through agents in order to continue to proliferate and promote their own growth. These agents are cytokines. Cytokines are regulators of the immune system that may be anti-inflammatory and/or pro-inflammatory. Hence, cytokines may be a possible target for therapeutic agents. A substance that has shown great potential to be a chemopreventive/therapeutic agent is curcumin. Curcumin, a yellow-pigment substance and active component of turmeric, has demonstrated anti-inflammatory, anti-tumor, and antioxidant effects. Curcumin has shown to modulate cytokine levels to intervene tumor proliferation. Since tumors often use the transcription factor NF-κB to modulate cytokines such as IL-6 and TNF-α to promote their own growth levels, identifying transcription factors and cytokines that are modulated by curcumin in mammary gland tumors may help find new ways to treat cancer. Hence, the aim of this study was to identify the interplay of select cytokines in the progression of ENU-induced mammary gland tumors in Apc Min mice. An additional aim was to determine the effects of curcumin on the reduction/inhibition of pro-carcinogenic cytokines. The study was approached by conducting immuno-histochemical (IHC) staining on paraffin sections of mammary gland to detect cytokine levels in 4 groups of ApcMin mice. The results showed that mice fed with curcumin diet display modulation of immune response in favor of inhibition of mammary gland tumor growth.

What inspired you to participate in undergraduate research?
Every research experience I had during my undergraduate career has helped me position myself in an optimal environment for learning. My experience at the oncology laboratory the past summer was no different.

How did you get your research position, and what preparation did you undertake for it?
I participated in this research project through the Travelers Summer Research Fellowship Program sponsored by Weill Cornell Medical College. Dr. Meena Katdare, an associate professor, was kind enough to allow me to work in her lab.

Where was your research experience located?
Weill Cornell Medical College in New York City

What did you get out of your research experience?
My research experience has helped me understand that pursuing a specific research problem requires patience, persistence, and close attention to detail.

ORAL PRESENTATIONS I

Searching for the Secrets of Strokes:
The Effects of Hypoxia and Conatokins on HEK Cells Transfected with NMDAR1a/2B.

Alexander Dzurik
Major: Biochemistry
Advisor: Francis Castellino, Department of Chemistry and Biochemistry
Coauthors: Rashna Balsara, Rachael Zhang, and Francis Castellino

Ischemia in the brain is the second most common cause of death in the western world. Elucidation of the *specific pathways* of neurons during strokes may contribute towards treatment of the condition. The *ionotropic receptors* are important factors in neuron communication and play a key role in certain pathophysiologies. In particular the N-methyl-D-aspartate (NMDA) receptor and pathways coupled to it are involved in ischemia-induced excitotoxic injury to the neuron. Since distinct subunit combinations of the NMDA receptor are known to govern injury-induced excitotoxic death, the human embryonic kidney (HEK) cells were co-transfected with the 1a/2B subunits. Conantokins (Con) are short γ-carboxyglutamate containing peptides and are naturally synthesized in sea snails. Conatokins possess neurochemical activity by acting as NMDA receptor antagonists and can modify receptor function by decreasing ion-channel gated current and calcium influx. The co-transfected HEK 293 cells were subjected to hypoxia in the presence of NMDA and the therapeutic effect of conantokins, specifically ConG and ConT was measured. It was observed that both ConG and ConT could promote survival of hypoxic cells as indicated by decreased apoptosis. Reorganization of actin fibers was observed in HEK 293 cells co-transfected with the 1a/2B NMDAR subunits and subjected to hypoxia and NMDA/hypoxia compared to control cells. The actin reorganization was partially reversed in the presence of ConG, but not by ConT. Thus suggesting that ConG and ConT may affect intracellular functions differently. These results demonstrate that conantokins ameliorate the damage of hypoxia and NMDA, and may serve as a possible treatment for stroke damage.

What inspired you to participate in undergraduate research?

It was highly encouraged throughout the biochemistry major to be involved in some type of research. Medical school advisors also highly encourage research to strengthen the application. I was interested to see what the research process was like, and have a greater appreciation for how we gain the knowledge that is considered to be common scientific knowledge now, but new hypotheses only years ago.

How did you get your research position, and what preparation did you undertake for it?

I contacted Professor Castellino at the end of my freshmen year. Through several meetings we agreed to a two-summer commitment at the Transgene Center, with part time research starting in my sophomore year. My first semester with the Center was spent learning various techniques to prepare for the summer research.

Where was your research experience located?

University of Notre Dame

What did you get out of your research experience?

The program has taught me a great deal about science, both theoretical principles and practical techniques used in lab work. It has given me a greater appreciation for the difficulties involved with science on the edge of what we know. I have also found that a lot of my lab work has helped me better understand the field of medicine. My experience shadowing a general surgeon was greatly augmented by my knowledge taken from the lab.

ORAL PRESENTATIONS I

Installation of a Laser Interferometry-based Position Monitoring System at the KEK Accelerator Facility

Kurt Jung
Major: Physics
Advisor: Michael Hildreth, Department of Physics
Coauthor: Michael McDonald, Cornell University

This project was to develop a straightness monitor for the Accelerator Test Facility (ATF) at the KEK National Accelerator Facility in Japan. This facility is currently used as a test bed for experimental beam focusing mechanisms to be installed in the upcoming International Linear Collider, a proposed high-energy linear accelerator at CERN, in Geneva Switzerland. Our straightness monitor aimed to increase the beam precision by using the techniques of laser interferometry and to provide the beam line with real-time position data. Without this position monitoring, the beam position monitor (BPM) vibrates at a very rapid rate and makes beam accuracy to our target of ~10 nm impossible. Using a Michelson interferometer, however, we were able to accurately measure the position of the BPM to within 7 nm, which is within the required precision for the proposed installation of the position monitoring system at the International Linear Collider.

What inspired you to participate in undergraduate research?
I was looking for a novel way to spend summer vacation, but more importantly, wanted to do research to help determine whether or not I wanted to do physics for the rest of my life.

How did you get your research position, and what preparation did you undertake for it?
I have been working with Professor Hildreth since late 2008 and he was kind enough to offer me a spot on his team this summer for the REU.

Where was your research experience located?
The University of Notre Dame and KEK in Tsukuba (Tokyo), Japan

What did you get out of your research experience?
I spent a great summer at Notre Dame and met some very interesting people from all over the country. Through the efforts of Professor Hildreth, my collaborator and I were able to travel to Tokyo, Japan for 10 days to actually install our interferometer system at KEK. Through the whole experience, I found I really enjoy experimental high energy physics and plan to try to continue with these studies in graduate school.

POSTER PRESENTATIONS

The Effect of Temperature on the Feeding Rate of **Papilio zelicaon** *Larvae*

Brian Argus
Major: Biological Sciences
Advisor: Jessica J. Hellmann, Department of Biological Sciences
Coauthors: Jillian M. Mueller, Jason D.K. Dzurisin, Derrick J. Parker

To predict how herbivorous species will be affected by changes in temperature, it is necessary to understand how their relationship with their food sources may change. In a study looking at the effect of altered temperature on different populations within a species' range, Pelini found that as temperature increased, the relationship between the butterfly *Papilio zelicaon* and several of its food plants, specifically *Petroselinum crispum* and *Lomatium utriculatum*, changed. As temperature increased, pupal mass of P. zelicaon individuals reared on *P. crispum* decreased dramatically. When individuals were reared on *L. utriculatum*, however, pupal mass increased. Both hosts were grown under the same climate conditions, which led to the conclusion that the observed effect of temperature might be due to differential feeding by the larvae. We investigated this finding further by measuring Fecal Matter Production (FMP), a measure of feeding rate, of individuals reared in climate conditions identical to those in Pelini's study. We fed larvae solely *P. crispum* and measured body size, mass, and feces at regular time intervals. To analyze the data, we created a FMP metric, which allowed us to run a T-Test to determine whether or not our results were significant. Preliminary results show that temperature is a significant factor in the feeding rate of *P. zelicaon*.

What inspired you to participate in undergraduate research?
I desire a career in focused on sustainability and doing research on a sustainable topic was the natural first place to start.

How did you get your research position, and what preparation did you undertake for it?
As a second semester freshman, I searched online for sustainability research internships for the summer and found the GLOBES program at Notre Dame. After emailing Dr. Hellmann and meeting with her to discuss her research, I knew this was what I wanted to do. I applied and was fortunate enough to get a position in her lab. To prepare Dr. Hellmann had me read several papers to familiarize myself with the lab as well as discuss several project ideas.

Where was your research experience located?
University of Notre Dame

What did you get out of your research experience?
I gained a much greater sense of what it actually means to do research from start to finish and during every phase in between. The experience also helped me discover more about my career goals.

POSTER PRESENTATIONS

Mitotic Activity Following Chemical Ablation of the Olfactory Epithelium in Zebrafish

Jordan Bergmann
Major: Science Pre-Professional
Advisor: Christine Byrd Jacobs,
Department of Neurobiology, Western Michigan University

The purpose of this study was to determine how the olfactory epithelium regenerates over a five day period. The fish were treated with Triton X-100—a non-ionic, soluble detergent—to destroy the cell membranes of olfactory epithelium cells. The fish were then killed at various time points. The tissue was reduced, embedded in paraffin, and treated with immunocytochemistry techniques involving the primary antibody, anti-proliferating cell nuclear antigen (PCNA) to examine mitotic activity. The epithelium suffered a significant reduction one day after treatment, but epithelial thickness regenerated after five days. Anti-PCNA showed that the rate of mitotic activity significantly decreased compared to normal levels for a short period. Between the second and third day after treatment, treated and untreated sides experienced a surge of growth with the side regions experiencing the most pronounced regeneration. Thus, chemical ablation using Triton X-100 causes a significant, albeit transient, effect on the olfactory epithelium in zebrafish.

What inspired you to participate in undergraduate research?

I have always been interested in neurobiology and I thought that this would be a great opportunity to get some experience in a professional lab setting.

How did you get your lab position and what preparation did you undertake for it?

I searched for summer lab positions and Western Michigan University's undergraduate research program had several projects that I was interested in, so I applied and was accepted. To prepare, I studied the olfactory system of the zebrafish along with different microscopy techniques since most of the work I did was under a microscope.

Where was your research experience located?

Western Michigan University

What did you get out of your research experience?

I learned how research is done in a professional laboratory setting, how to present research to the scientific community, and how to publish papers.

POSTER PRESENTATIONS

Determination of Neutron Branching in $^{12}C+^{12}C$ Fusion

Justin Browne
Major: Physics
Advisor: Xiaodong Tang, Department of Physics

The neutron branch of the $^{12}C+^{12}C$ is important for the carbon shell burning and carbon explosive burning. The ^{23}Mg created by the $^{12}C(^{12}C,n)^{23}Mg$ reaction may undergo β^+ decay, changing the neutron excess in the combusting material, and the neutrons emitted from this reaction may contribute to s- and r-processes. Both the β^+ decay and the neutron emission greatly affect the subsequent nucleosynthesis in the star. Here, we have developed a detection system, consisting of an array of four plastic scintillators and two Germanium detectors, to detect the decay of the^{23}Mg. We have tested the system at SEc.m.=4.24 MeV and unambiguously identified the ^{23}Mg reaction products using β+-γ coincidence technique.

What inspired you to participate in undergraduate research?
I love asking questions and answering them in the lab. Also, I could not turn down the opportunity to synthesize small-molecules that kill tumors.

How did you get your research position, and what preparation did you undertake for it?
I have been a member of the Miller Group since January of 2007, so I was ready to jump into the lab as soon as I arrived. After submitting a research proposal based on an extension of my academic-year research, the Notre Dame College of Science Summer Undergraduate Research Fellowship provided funding for my research."

Where was your research experience located?
University of Notre Dame

What did you get out of your research experience?
An exciting summer at Notre Dame, new friends, and new collaborators! I also learned how to conduct interdisciplinary research, write grants, and publish results. My research experience in the Miller Group provided a solid basis for my future graduate studies.

POSTER PRESENTATIONS

Financial Mathematics: Sustainable Energy Development Model

Conor Bruen
Major: Mathematics and Economics
Advisor: Alex Himonas, Department of Mathematics
Advisor: Tom Cosimano, Department of Finance

The desire for renewable energy sources comes from the scarcity of resources required for production processes. The key to making any production process as efficient as possible is getting as much out of one's inputs as possible or optimizing production from those inputs. Creating an accurate model of the entire production process is necessary to solve an optimization process, and is an important aspect of financial mathematics in relation to many areas besides renewable energy. The models currently available for energy consumption and production are not very precise or comprehensive of the actual situation present. It is important to model each aspect of the process of energy production as well as the energy markets in which the energy is distributed. This problem will be optimized to a point infinitely far in the future to account for future generations that need reliable energy sources.

What inspired you to participate in undergraduate research?
I found undergraduate research to be a great way to apply my studies in mathematics and economics to important problems in the world today. Economic modeling also provides a much deeper understanding in economics classes as well as a venue to apply new methods learned in mathematics classes.

How did you get your research position, and what preparation did you undertake for it?
I began readings with Professor Himonas late in my sophomore year and became interested in the topics of his research. I stayed at Notre Dame for the summer before my junior year beginning my research and creating the model that I plan to optimize.

Where was your research experience located?
University of Notre Dame

What did you get out of your research experience?
My summer at Notre Dame was very productive, as it allowed me to focus completely on understanding and creating a model of the problem I am trying to solve. Although the research pertains to problems outside of the classrooms, the methods of thinking necessary for research in financial mathematics are very helpful in the classroom.

POSTER PRESENTATIONS

Sex-Based Differences in the Response of Human Bone Marrow and Fibroblast Cells to Nutritional Stress

Kristina Cieslak
Majors: Science Pre-Professional and Psychology, Minor: Honors Program
Advisors: Constance Chu, Christian Coyle
Cartilage Restoration Laboratory, University of Pittsburgh

Bone marrow cells are currently being studied for use in potential repair strategies for treatment of cartilage defects. Cartilage defects and other early signs of cartilage degeneration contribute to the development of degenerative osteoarthritis. Recent studies have shown that osteoarthritis is more prevalent in females and that microfracture, a primary treatment technique used to stimulate cartilage repair, is more successful in young, active males (Ryami and Rolf, 2009). This suggests that cartilage repair potential may differ between males and females. Our study investigated whether an underlying difference exists between male and female human bone marrow and human fibroblast cells outside of their respective hormonal environments when exposed to conditions of nutritional stress. Sex-segregated human bone marrow (four males, six females) and human fibroblast (three males, three females) cells were cultured in feeding media as a control condition or in feeding media without fetal bovine serum to induce starvation. The density of autophagy-associated protein LC3II was measured along with neutral lipid accumulation at 0, 4, 24, 48, and 72h. Preliminary results indicated no difference in autophagy between males and females in bone marrow, but rather a difference in lipid metabolism, under starvation conditions. A larger sample size is needed to expound on the trends seen.

What inspired you to participate in undergraduate research?
I wanted to have a summer experience where I would learn something new every day and be able to impact my future field of medicine.

How did you get your research position, and what preparation did you undertake for it?
I worked in the Cartilage Restoration Lab at the University of Pittsburgh Medical Center the summer after my freshman year, and was asked to return this past summer. I took on my own project this year which required a great deal of literature research on the topic and protocol adjustments before the experiment could be underway.

Where was your research experience located?
University of Pittsburgh Medical Center Orthopaedic Research Laboratory

What did you get out of your research experience?
Taking on my own project was one of the most rewarding and also most frustrating experiences that I have had to date. The data doesn't always come out the way you want it to/think it should, but I had to learn to take it in stride and that it's all a part of the process. Looking back on all of the work I had done and all of the techniques and new information I had learned at the end of the summer was a fantastic feeling.

POSTER PRESENTATIONS

The Localization of Allopregnanolone in the Adult Mouse Brain

Allie Colaco
Major: Biological Sciences
Advisor: Synthia Mellon,
Department of Reproductive Sciences/OBGYN, University of California - San Francisco

Allopregnanolone (ALLO) is a neuroactive steroid that is synthesized and metabolized in the brain, and may be used for therapy for Neimann pick type C. ALLO is a derivative of progesterone and acts as a positive $GABA_A$ receptor modulator. In the study, we localized ALLO to different areas in the brain using immunohistochemistry to determine if non-naturally occurring ALLO localizes to the same regions of the adult mouse brain that naturally produced ALLO does. Additional ALLO was applied to wild-type adult male mice, that were naturally producing ALLO in the body, and an increase of expression was found in some regions. Areas that lacked steroid expression were found in both ALLO injected and control mice, suggesting that non-naturally occurring ALLO localizes to specific regions rather that throughout the entire brain. Further experimentation is necessary to determine if there is a significant difference in levels found when ALLO is injected compared to the naturally occurring levels, as well as what the levels of ALLO expression would be when injected into ALLO deficient mice. This has therapeutic implications because it allows injections of the neurosteroid to a deficient individual to localize to the same regions that naturally occurring ALLO should be.

What inspired you to participate in undergraduate research?

I have always been interested in doing research and thought that this was a great opportunity to partake in especially with it being so close to home.

How did you get your research position, and what preparation did you undertake for it?

I searched online for labs close to where I live that were researching things I found interesting and I found Dr Mellon. I met with her during winter break and told her I was interested in the work that her lab was doing and would like to work there over the summer. To prepare for starting in the lab I just read a lot of literature that they had published and also on other relevant papers so that I had more of an understanding of what I would be working on.

Where was your research experience located?

University of California - San Francisco

What did you get out of your research experience?

It was my first time working in a lab so I gained a lot of new skills and learned how do things I might not have had the opportunity to do otherwise. But I also got a chance to see how a lab runs and learn about grants and funding. Also I got over my fear of blood!

POSTER PRESENTATIONS

Schwann Cell Response to Axially-Aligned Fibrin Scaffolds

Lauren Corona
Major: Biological Sciences
Advisor: Justin M. Saul,
Virginia Tech-Wake Forest University School of Biomedical Engineering/
Wake Forest Institute for Regenerative Medicine

The cascade of events following a serious injury to the Peripheral Nervous System (PNS) leads to the deposition of cell debris and inhibitory molecules that obstruct robust regeneration. Injuries that result in 10-15mm gaps can be bridged by surgical coaptation or through the use of autologous neural tissue. However, for gaps longer than this, treatments are limited and generally result in poor functional outcomes. The availability of an off-the-shelf alternative to autologous or allogeneic tissue sources would be a significant clinical benefit to the treatment of peripheral nerve injuries, and a scaffold generated from biomaterials would pose as a suitable option. In addition to their potential for bulk manufacture, biomaterial scaffolds are appealing in that their architecture can be controlled to provide a physical substrate for more rapid and robust cellular regeneration. Because Schwann cells provide support for neural regeneration following injury, their implementation into biomaterial scaffolds is likely to enhance axonal regeneration. We developed such scaffolds with well-defined architecture in which intraluminal conduits are axially aligned. As an initial study, we sought to investigate the interactions of RT4-D6P2T (RT4) cells, rat Schwannoma cells, when seeded on conduits of various diameters. We hypothesized that our scaffolds would allow for control over Schwann cell morphology that may ultimately promote axonal regeneration. Preliminary results show that RT4 cells are supported and guided by the architecture of axially-aligned intraluminal fibrin scaffolds. Cells were observed to extend processes and to infiltrate through the scaffold conduits. This is a promising result in terms of axonal regeneration as the Schwann cells would serve to aid the growth of axons as they infiltrate the lumen of the scaffold channels.

What inspired you to participate in undergraduate research?
I have done it before at Notre Dame and sought to broaden my depth of knowledge and techniques this summer at Wake Forest. Working in the research field always has new and exciting opportunities to offer.

How did you get your research position, and what preparation did you undertake for it?
I submitted an application to the Wake Forest Institute for Regenerative Medicine Summer Scholars and was selected.

Where was your research experience located?
Wake Forest Institute for Regenerative Medicine; Winston-Salem, NC

What did you get out of your research experience?
An exciting summer in Winston-Salem. I met researchers from all over the world that came to the institute on fellowships due to its international reputation. Further, I grew and matured as an emerging scientist capable of independent thought.

POSTER PRESENTATIONS

Synthesis and electrochemistry of glycolate and alpha-hydroxycarboxylate derivatives of redox-active titanium tetraazaannulene compounds

Brian S. Dolinar
Major: Chemical Engineering
Advisor: Seth N. Brown, Department of Chemistry and Biochemistry
Coauthors: Andrew J. Loza

A crucial problem faced by fuel cell technology today is how to coordinate outer-sphere single electron transfer operating in electric circuits with two electron bond-breaking processes operating in fuel oxidation. It is possible that this problem can be solved through catalysis using a metallic center to coordinate the interaction between a non-innocent redox-active ligand and a fuel. Described here is the preparation of two suitable tetraazaannulene ligands, one with a redox-active dianisylamine group and one with a simple tolyl group. The ligands are metalated with $TiCl_4$, and the titanium is further ligated to 1,2-diols or α-hydroxycarboxylic acids in order to form eight analogous compounds for study. The results of chemical oxidation and electrochemistry experiments indicate that removing electrons from the non-innocent ligand with a suitable outer-sphere oxidant readily cleaves the C-C bond in the glycolates. The results of oxidation of the dianisylamine substituted α-hydroxycarboxylates showed a lack of cleavage of the C-C bond, making these compounds useful for future study of these reactions' intermediate species.

What inspired you to participate in undergraduate research?

I began work in undergraduate research because a friend of mine in my chemistry class freshmen year suggested it. He talked about how he thought that it would be fun to be involved in solving problems through chemistry research. Before he mentioned it, I had not really considered doing research as an undergraduate, but after he suggested it, I began to look at some of the research going on at ND, picked the project I liked best, and then contacted the professor to begin research.

How did you get your research position, and what preparation did you undertake for it?

In January 2007, as a freshman, I began researching with Professor Brown. I continued for the rest of freshman and sophomore years. In the summer of 2008, I was looking to extend my research experience from simply a semester experience to a full-time job for the summer, and Professor Brown encouraged me to continue working in his lab. I enjoyed my experience so much that I decided to continue researching in the Brown lab during the summer of 2009.

Where was your research experience located?

University of Notre Dame

What did you get out of your research experience?

Research can be a very rewarding career. Granted, there are days when absolutely nothing works, but there are plenty of days that are filled with successful experiments. My experience has taught me how to learn something from failures as well as the successes in the laboratory.

POSTER PRESENTATIONS

The Potential Role of MicroRNAs in Asthma Susceptibility

Patrick Dooling
Major: Science-Business
Advisor: Marsha Wills-Karp, Division of Immunobiology,
University of Cincinnati College of Medicine
Coauthors: Krista Dienger, Alyssa Sproles, Ian Lewkowich, Stephane Lajoie, and Chinavenmeni Velu

Asthma is a chronic inflammatory disease that affects 5-10% of the US population. It is characterized by inflammation of the airways, tissue remodeling, and increased mucus production that leads to airway hyperresponsiveness. Although the etiology of disease is unknown, it is thought to be driven by inappropriate Th2 immune responses to inhaled antigens. Recent studies suggest that microRNAs, a form of RNA interference, may be important in the endogenous control of gene pathways regulating airway inflammation. To determine which miRs play a role in the asthma phenotype, a miRNA microarray and miRNA Taqman probe quantitative RT-PCR validation was carried out on RNA isolated from lung tissue harvested from mice we have previously shown to be either resistant (C3H) or susceptible (A/J) to exposure to the common allergen, house dust mite. We identified several miRs that were either up or downregulated by allergen in the two strains of mice. MiR-21 was upregulated significantly in mice treated with HDM. In addition, miR-467b was downregulated in A/J mice, but upregulated in C3H mice. Mir-21 was further studied in a mouse model using antagomirs (anti-miRs) to block its action. *In vivo* antagomir treatment of the A/J mice had no significant effect on either airway reactivity or cellular inflammation as these parameters did not differ in mice given control antagomirs and those treated with antagomir miR-21. Thus, we conclude that although miR-21 is highly upregulated in our model, it does not play a role in the parameters we measured. Further studies are underway to examine the role of the additional candidate miRs we identified in this study and may provide novel drug targets for the treatment of asthma.

What inspired you to participate in undergraduate research?
I have always wanted to do biomedical research in hopes of finding cures to diseases. As a student majoring in the College of Science, I wanted to use the knowledge and skills I learned in the classroom to help others through research.

How did you get your research position, and what preparation did you undertake for it?
I obtained the summer fellowship by applying to the University of Cincinnati's Summer Undergraduate Research Fellowship (SURF) Program. I prepared by doing research here on campus with Dr. Tracy Vargo-Gogola where I continue to research breast cancer.

Where was your research experience located?
The program was through the University of Cincinnati but my lab was associated with the Cincinnati Children's Hospital Research Foundation.

What did you get out of your research experience?
I learned a lot about different techniques that I had never seen in my lab here on campus. I also made a lot of friends in the lab, got to see how research in a major research foundation happens, and learned about the whole research process by beginning my own work and following it through to completion.

POSTER PRESENTATIONS

Role of ID2 (Inhibitor of DNA binding 2) in the Mammalian Circadian Clock

Shanik Fernando
Major: Biological Sciences
Advisor: Giles E. Duffield, Department of Biological Sciences
Coauthors: Sarah Ward, Tim Hou

Circadian rhythms are an essential component of life which regulate many physiological, biochemical, and behavioral processes. These 24 hr rhythms are driven by the master clock located in the suprachiasmatic nucleus in the hypothalamus of the brain. The SCN receives photic input via the retinohyopthalmic tract, and acts to signal peripheral oscillators throughout the body and modulate physiological responses. These responses are due in part to the intrinsic rhythms in each tissue, for example as much as 10% of expressed genes in the heart are under local clock control. Disorders of circadian timing have been linked to metabolic and cardiovascular disease, therefore understanding the molecular basis and physiology of the biological clock is critical to the development of new medical diagnoses and treatments.

This study examined the transcriptional inhibitor ID2 (*Inhibitor of DNA binding* 2) as a potential modulator of the mammalian circadian clock. The current model suggests that *Id2* is a novel clock component which modulates INPUT, master pacemaker, and OUTPUT of the clock. Interactions between ID2 and CLOCK/BMAL1 were demonstrated using the GAL4 /VP-16 mammalian two-hybrid interaction system. The identification of the Helix-Loop-Helix (HLH) region as the relevant binding region was performed by *in-vitro* transient transfection with over expressed proteins. In addition it has been shown that ID2 operates rhythmically at both the transcript and protein levels in the mammalian heart. Therefore, ID2 regulation of gene expression within the cardiac system will be determined using qRT-PCR; positive results would confirm recent findings suggesting that ID2 is involved in modulating the biological clock.

What inspired you to participate in undergraduate research?

I have always wanted to do something novel, and explore the answers to questions which remain unanswered

How did you get your research position, and what preparation did you undertake for it?

I joined the Duffield lab in Winter of 2009, and wanted to continue research during the summer. I submitted a research proposal to the Notre Dame College of Science Summer Undergraduate Research Fellowship which awarded the funds for my research.

Where was your research experience located?

University of Notre Dame

What did you get out of your research experience?

I enjoyed learning new techniques as well as what it means to be a full time researcher. This experience provided a unique perspective on the scientific process, and has encouraged me to continue with research as a career.

POSTER PRESENTATIONS

*Long range gene flow has influenced the evolutionary history of long-tailed macaques (***Macaca fascicularis***) on the island of Bali, Indonesia*

Andy Gloss
Major: Biological Sciences
Advisors: Hope Hollocher, Department of Biological Sciences and
Agustín Fuentes, Department of Anthropology
Coauthors: Kelly Lane

The long-tailed macaque (*Macaca fascicularis*) is one of the most successful non-human primate species radiations, with a wide range extending throughout Southeast Asia. Gene flow between geographically separate regions has influenced the evolutionary history of this species, particularly in Indonesia, where land bridges have connected the Malay Peninsula of continental Asia and the islands to the south as recently as 15,000 years ago. Male-mediated gene flow, consistent with male dispersal and female philopatry, is reflected in the presence of two Y chromosomal haplotypes in the island of Sumatra – one originating in continental Asia and the other found only in the neighboring islands. In this study, two Y chromosomal regions were sequenced from macaques on the Indonesian island of Bali, which once temporarily formed the southeast tip of a large, continuous landmass united with continental Asia during periods of low sea level. Both the continental and insular Y chromosomal haplotypes were detected, revealing that nuclear gene flow out of continental Asia reached much further than previously known. Additionally, the insular haplotype present on Bali clustered phylogenetically with the haplotype present in the neighboring island of Java, which suggests a particularly close genetic relationship between macaques of these islands. Both haplotypes were widely distributed throughout Bali, showing that male dispersal events have connected the island's spatially distinct populations over a large timescale.

What inspired you to participate in undergraduate research?

After taking a few biology classes and labs, I thought a career in research might be right for me – and there's no better way to find out for sure than experiencing it firsthand.

How did you get your research position, and what preparation did you undertake for it?

I began working in Dr. Hollocher's lab during my sophomore year, so I applied for funding from the Biology NSF REU program at Notre Dame to continue my position over the summer after my junior year.

Where was your research experience located?

University of Notre Dame

What did you get out of your research experience?

I made great friends during my summer at Notre Dame, increased my knowledge of grant writing and the scientific process in a university setting, and helped prepare myself for grad school next year.

POSTER PRESENTATIONS

Optimized Bunching at Notre Dame

Frederick Jung
Major: Physics in Medicine
Advisor: Ani Aprahamian, Department of Physics
Coauthor: Wanpeng Tan

Ion sources for nuclear accelerators produce a constant stream of particles, but for some nuclear reactions, it is useful to have discrete packets of accelerated particles hit the target. Bunchers create these groups of particles that hit a target at a specific point in time. This project found optimum buncher settings for ^{4}He and proton beams at Notre Dame's FN Tandem Accelerator. A tantalum target was bombarded with the ^{4}He and the proton beams. The resultant gamma rays were detected by a BaF_2 detector placed outside the target chamber. In this way, the resolution of each setting could be determined, and ultimately, the optimal resolution could be found. The optimal resolution was found to be 1.82ns for ^{4}He, when the buncher was set at 95mV, the sweeper was set at 2V, and the High Voltage Platform was set at 30kV. The optimal resolution for the proton beam was not able to be found, as a clean resolution could not be achieved. This means that a more extensive study of the SNICS ion source needs to be made in an attempt to optimize the beam.

What inspired you to participate in undergraduate research?

I really wanted a chance to get to use the physics I had learned in the classroom in a lab setting. I had heard that research experience was very valuable, from interacting with amazing professors to getting a glimpse at what a life of research would entail.

How did you get your research position, and what preparation did you undertake for it?

To get my research position, I emailed about seven or eight physics professors in the December of 2008. Of the ones that said they didn't have space for me, almost all referred me to someone else. Two professors agreed to take me in their research groups, and both let me know a little bit about what they did. I chose Dr. Aprahamian's group because it was an experimental group and the research she was doing seemed very interesting. Dr. Aprahamian told me that she wanted to keep me at school over the summer, so we applied for funding and I was eventually accepted into Notre Dame's Research Experience for Undergraduates (REU) program.

Where was your research experience located?

University of Notre Dame

What did you get out of your research experience?

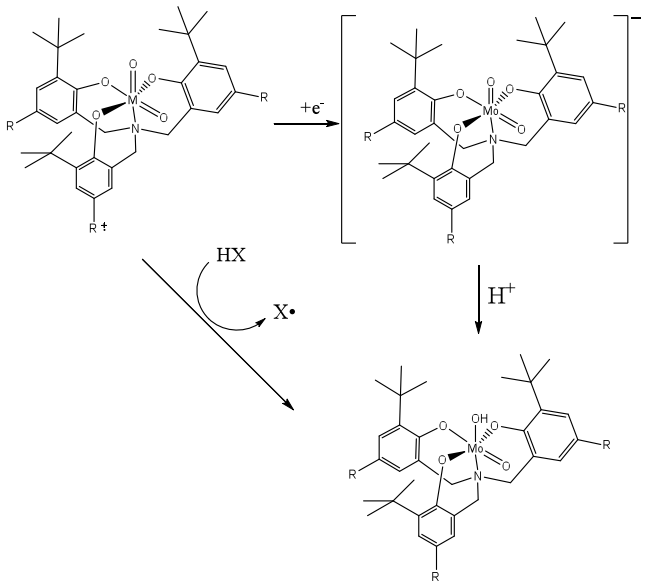
I learned so much about doing research and the lives of research scientists. Working in the REU gave me a great chance to interact with other students from other schools in both similar and different fields. I did what a research scientist does. I read papers. I ran experiments with Notre Dame's largest nuclear accelerator. I even got to present my work at a Nuclear Physics conference in Hawaii. My research has really given me a desire to be a researcher to discover new science and further our understanding of our world.

POSTER PRESENTATIONS

Synthesis and Proton-Coupled Electron Transfer Reactions of Molybdenum and Tungsten Dioxo Complexes

Andrew Medvecz
Major: Chemistry
Advisor: Seth N. Brown, Department of Chemistry and Biochemistry
Co-author: Davide Lionetti

Proton-coupled electron transfer (PCET), resulting in net hydrogen atom transfer, is a process of great interest in oxidation chemistry. We are interested in the use of PCET in metal-oxo complexes with redox-active organic ligands, in particular molybdenum- and tungsten-dioxo complexes. PCET in these complexes would be unusual because the proton would end up on an oxo group and the electron on a different ligand. In this study, the redox-active ligand is an amine trisaryloxide ligand L with substituents of differing electron-donating properties (^{t}Bu, OCH_3, $N[C_6H_4OCH_3]_2$). The anionic compounds $[Bu_4N][LMO_2]$ (M=Mo, W) were prepared from the triphenols and Na_2MO_4, and protonated to form the neutral oxo-hydroxide compounds LM(O)(OH). The pK_a's of LM(O)(OH) were determined through UV/Vis spectrophotometry and the oxidation potentials of the anions LMO_2^- were found through cyclic voltammetry. Together these values determine the hydrogen atom affinity of the neutral radicals LMO_2. It was found that the tert-butyl substituted complexes for both metals were stronger hydrogen atom acceptors than the methoxy substituted complexes and that the tungsten complexes are stronger hydrogen atom acceptors than the corresponding molybdenum complexes. The next step in the research of these compounds is to generate and characterize the neutral radicals and to investigate their reactivity in oxidation-reduction reactions.



What inspired you to participate in undergraduate research?
Research is a great opportunity to develop a deeper understanding of the material that one learns from lectures and labs. I began my participation as a means of increasing my knowledge of chemistry and applying it to a unique project.

How did you get your research position, and what preparation did you undertake for it?
I have been a member of the Brown Group since January of 2008 when I spoke to Prof. Brown about beginning a project with a focus in organometallic complexes. My preparation included lecture and laboratory courses as well as literature research on the topic.

Where was your research experience located?
University of Notre Dame

What did you get out of your research experience?
My research experience has not only strengthened my understanding of chemistry but also developed my problem-solving and task-management skills. I have also learned the value of good presentation skills and concise scientific writing.

POSTER PRESENTATIONS

Fibrin-Dependent Formation of Extracellular Traps for Bacterial Control

Alex Metoxen
Major: Biological Sciences
Advisor: Mike Munks, Department of Immunology, University of Colorado Denver - School of Medicine and National Jewish Health

The clotting protein fibrinogen helps control bacterial infections by limiting their spread. Fibrinogen also interacts with the cell surface receptor CD11b, found on neutrophils and other cells. Recent research has revealed that neutrophils can release Neutrophil Extracellular Traps (NETs), composed of chromatin and anti-microbial enzymes, which trap and kill bacteria. We hypothesized that the ability of fibrinogen to limit bacterial spread may be linked to its ability to recruit cells expressing CD11b, such as neutrophils, to sites of bacterial infection. To test this, we injected C57BL/6 mice intra-peritoneally with heat-killed *Streptococcus pneumoniae*. Several hours later, small white aggregates formed within the abdominal cavity. We showed by western blot analysis that these aggregates contained the clotting protein fibrinogen. In addition, histone H3 and citrullinated H3 were detected via western blot analysis, indicating the presence of extracellular traps. These data suggest that fibrin recruits CD11b+ cells to kill bacteria that it has previously trapped. Live Strep did not form aggregates, implying that Strep may have mechanisms for evading extracellular traps in the C57BL/6 mouse model.

What inspired you to participate in undergraduate research?
I wanted to start getting research experience, and with my interest in medicine immunology was the perfect area to begin.

How did you get your research position, and what preparation did you undertake for it?
I applied to the new Alumni Mentor Internship Program through the Biology Department and was given the opportunity to take a volunteer position in Denver. To help cover the expenses, I applied for a grant through the university. I knew that I would be working with mice, so I practiced handling them at one of the facilities on campus.

Where was your research experience located?
National Jewish Health located in Denver, CO

What did you get out of your research experience?
I learned more about immunology during my internship than I could have learned in a full semester of classes. I also learned many new lab techniques and their practical applications. I became friends with many of the other graduate students and post-doctorates in the lab and was able to play basketball with them twice a week. My landlords also took my roommate and I on a trip through the Rocky Mountains and wine country one weekend.

POSTER PRESENTATIONS

The R-process, nucleosynthesis, and new nuclear masses

Nancy Paul
Major: Physics
Advisor: Ani Aprahamian, Department of Physics
Co-Author: S. Brett

Precise, accurate measurements of nuclear masses are crucial for astrophysical modeling, reproducing the observed solar abundances of the elements, and for disentangling the nuclear physics imprinted on those abundances. More generally, masses are necessary for understanding nucleosynthesis via the r-process, thought to be responsible for over 50% of the elements heavier than Iron. The advent of ion traps and storage rings has generated a profusion of very precise measurements since the 2003 Atomic Mass Evaluation. I compiled an up-to-date list of new measurements from labs worldwide and incorporated them into Bradley Meyer's (Clemson University) classical model of the r-process to examine the impact of the new measurements. Sensitivity studies of various theoretical mass models and the new measurements in the r-process code, showed the largest deviations in the A = 70− 85 mass region. These studies will be used to plan new measurements of nuclei along the r-process path, near 78 Ni.

What inspired you to participate in undergraduate research?
I love learning about the nature of the universe, especially things that have not yet been discovered. Nuclear physics at Notre Dame offered the perfect outlet to contribute to new understanding of the building blocks of our universe.

How did you get your research position, and what preparation did you undertake for it?
I have worked with Dr. Ani Aprahamian from literally my first day on campus as a freshman and had the opportunity to continue my research through REU funding from the NSF. There was no formal preparation, just lots of work to learn on my own and find answers to difficult questions whose scope I did not easily grasp.

Where was your research experience located?
University of Notre Dame

What did you get out of your research experience?
Exciting stimulation and challenges unlike anything encountered in my classes, the background and material to converse with high level physicists, the opportunity to publish and present my work to the Division of Nuclear Physics and the Japanese Physical Society in Hawaii, and the stepping stone to a future career in nuclear astrophysics research.

POSTER PRESENTATIONS

C1q enhances phagocytosis of Mycobacterium avium through a pertussis toxin sensitive pathway

Kristen Ploetze
Major: Biological Sciences
Advisor: Suzanne Bohlson, Department of Biological Sciences,
Department of Microbiology and Immunology, Indiana University School of Medicine - South Bend

The mycobacteria are intracellular pathogens, relying on efficient entry into the host macrophage to establish and sustain an infection. C1q and MBL are members of a family of pattern recognition molecules called defense collagens, known to bind to certain pathogens, as well as apoptotic cells and trigger an enhancement of phagocytic activity. C1q and MBL also trigger a dampening of proinflammatory cytokine production and an upregulation of anti-inflammatory IL-10 from human monocytes. A concurrent enhancement of phagocytosis of apoptotic cells and diminution of proinflammatory cytokine production by defense collagens would be beneficial in clearance of apoptotic cells; a process that occurs normally in the absence of inflammation. However, during uptake of mycobacteria, defense collagen triggered phagocytosis and dampening of proinflammatory cytokine production may be beneficial to the pathogen. Here we demonstrate that C1q triggered an enhancement of phagocytosis of *Mycobacterium avium* from mouse bone marrow derived macrophages (BMDM). TNF-alpha production was reduced from BMDM exposed to C1q-opsonized mycobacteria despite the higher levels of phagocytosis. C1q-mediated enhanced phagocytosis was sensitive to pertussis toxin (PTx), implicating a G-protein coupled receptor (GPCR) is essential to the process. PTx inhibited C1q-enhanced ingestion of *M. avium* when macrophages were adherent to C1q and when C1q was used to opsonize the mycobacteria. In addition, BMDM adherent to C1q displayed an average 4.4-fold enhancement of Fc-receptor mediated phagocytosis which was inhibited with PTx. Importantly, fibronectin mediated enhanced phagocytosis was insensitive to PTx demonstrating that PTx is not a global inhibitor of phagocyte function. Similar results were observed from human monocytes. These data suggest that mycobacteria, similar to apoptotic cells, utilize defense collagens to promote rapid ingestion in the absence of inflammation and for the first time implicate a GPCR dependent pathway in defense collagen triggered phagocytosis.

What inspired you to participate in undergraduate research?

I wanted to challenge myself more in my study of biology by undertaking an independent study research project. During that project I captured the fire that comes with the discovery of new information, which inspired me to join a research lab on campus.

How did you get your research position, and what preparation did you undertake for it?

I applied to work as undergraduate research assistant in Dr. Bohlson's lab at the end of my sophomore year. I had just completed my independent study project in cell biology, so I was equipped with the technical skill and experience enabling me to contribute to the lab right away.

Where was your research experience located?

University of Notre Dame/Indiana University School of Medicine—South Bend

What did you get out of your research experience?

My research experience has been a great supplement to my education at Notre Dame. Through my research experience, I am able to explore studies I'm interested in beyond what is provided in the textbook.

POSTER PRESENTATIONS

Acylated Isoxazolidines: Potential Scaffolds for a New Class of Antibiotics

Jimmy Rudloff
Major: Biological Sciences
Advisor: Marvin J. Miller, Department of Chemistry and Biochemistry

No single event in the history of mankind has caused a greater jump in the average lifespan of human beings than the discovery of antibiotics. The most successful class of antibiotics has been the beta-lactam, used for its low toxicity in humans and broad spectrum of application. Despite humanity's fortune at the discovery of these drugs, the evolutionary abilities of bacteria to adapt and counter antibiotics have caused humanity to enter a biological arms race to develop new and innovative antibiotics. Nearly 70% of pathogenic bacteria possess resistance to at least one type of antibiotic. However, previous research by the Miller group at Notre Dame has shown that the beta-lactam ring is not entirely necessary for activity against bacteria and the system can be mimicked. One such compound that has shown promising biological activity in the past is the acylated isoxazolidine-3,5-dicarboxylic acid. Using this compound as an evolvable scaffold, the intent of my research is to synthesize a new class of antibiotics that have similar strength and low toxicity as beta-lactams but are able to avoid bacteria's methods of resistance. My research has three main focal points: derivatizing the compound with different side chain groups, determining whether the core must be composed of a single ring or more, and testing the compounds *in vitro* for activity. Due to rising costs of drug discovery by pharmaceutical companies, research into the synthesis of novel, biologically active compounds are becoming a major concern for the scientific community. Research into isoxazolidines and their derivatives may lead to major breakthroughs in the fight against drug resistant bacteria.

What inspired you to participate in undergraduate research?

I became very interested in undergraduate research in my freshman year. Being around Dr. Miller and other Notre Dame professors, I wanted to try applying myself in an environment that was both engaging and challenging. Organic chemistry interested me more than most fields, and I quickly came to enjoy working with Dr. Miller and his lab.

How did you get your research position, and what preparation did you undertake for it?

Dr. Miller was my organic chemistry professor, and I went to his office hours quite a bit. After hearing about research and learning from Dr. Miller in class, I felt compelled to, at the very least, try research. Dr. Miller greatly approved, and I began in the fall of my sophomore year.

I prepared by reading articles Dr. Miller suggested and by simply being ready to learn a difficult and intriguing field.

Where was your research experience located?

I have worked in Dr. Miller's lab at Notre Dame both semesters last year, and I worked for Eli Lilly and company this past summer.

What did you get out of your research experience?

I've learned a great deal about organic chemistry and the career opportunities after undergrad. I've met countless people in the field that are both brilliant and very supportive. Perhaps most impressively, I worked for Eli Lilly and Company this past summer as an organic chemist. This was one of the better experiences in my life, and I'm so grateful to Dr. Miller for the opportunity.

POSTER PRESENTATIONS

The Role of the Vsx2 Transcription Factor in Zebrafish Retinal Regeneration

Jerry F. Shields
Major: Biological Sciences; Chinese
Advisors: Travis Bailey and David R. Hyde, Department of Biological Sciences

The zebrafish (*Danio rerio*) is an organism with the ability to regenerate its retina, but the specific genes involved in this process still need much study. The gene *vsx2*, also known as *chx10*, is a putative signal during retinal regeneration due to its requirement during retinal development in Müller Glial cells, which are the retinal cells that differentiate to cause regeneration. Animals without vsx2 experience reduced proliferation of Müller Glial cells during retinal development, resulting in microphthalmia (smallness of the eye). As the role of vsx2 in retinal development has been previously characterized, the goal of this study is to determine the role of vsx2 in retinal regeneration. Transgenic Vsx2 zebrafish, with the GFP gene inserted after the Vsx2 promoter (*Tg(chx10:EGFP)* zebrafish) were given a Vsx2 morpholino to knock down Vsx2 expression. Following light-induced degeneration of *Tg(chx10:EGFP)* zebrafish retinas, fish with Vsx2 morpholino injections showed reduced Müller Glial cell division and proliferation during retinal regeneration as compared to contralateral eyes. This data suggests that during retinal regeneration, Vsx2 is required for full regenerative potential.

What inspired you to participate in undergraduate research?
Before joining Dr. Hyde's laboratory, I had heard that zebrafish retinal research could in the long-term lead to curing human blindness. I was compelled and wanted to become involved in zebrafish research thereafter.

How did you get your research position, and what preparation did you undertake for it?
I looked into various professors and their research topics, and after gaining interest in Dr. Hyde's laboratory, I read several of his papers and talked to him about his research. For preparation, I read several articles to gain a general understanding of retinal regeneration.

Where was your research experience located?
"University of Notre Dame"

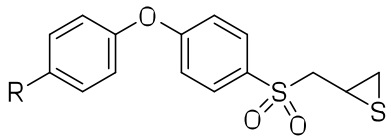
What did you get out of your research experience?
Research has been quite challenging, and the research questions have been complex. I have developed the desire answers to find answers to these questions, and have developed a thirst for discovery. Through this research, I was able to substantially appreciate discovery and lifelong learning.

POSTER PRESENTATIONS

Kinetic Characterization of Second-Generation Gelatinase Inhibitors

Rachel Staran
Major: Chemistry
Advisors: Shahriar Mobashery and Mayland Chang, Department of Chemistry and Biochemistry
Coauthors: Mijoon Lee, Sebastian Testero, Marta Toth, Rafael Fridman, Shahriar Mobashery, and Mayland Chang

Gelatinases are members of a family of zinc-dependent endopeptidases called matrix metalloproteinases (MMPs), which have been shown to be involved in the pathology of stroke. Thus, the gelatinases (MMP-2 and MMP-9) are critical targets for chemical inhibition. A number of potent and selective gelatinase inhibitors have been previously synthesized and studied, including compound **1**, which has shown great promise in animal models of stroke. Compound **1** is readily metabolized primarily via oxidation at the *para*-position of the terminal phenyl ring and oxidation alpha to the sulfonyl to give a sulfinic acid. The *p*-hydroxy metabolite is a more potent gelatinase inhibitor than the parent compound **1**. In order to decrease metabolism, a series of *p*-substituted derivatives of compound **1** were synthesized, as well as analogs in which one of the phenyl groups was eliminated. The kinetics of inhibition for these compounds was investigated. In the current study, kinetic analysis characterizing the rate of onset of inhibition (k_{on}), reversal of inhibition (k_{off}) and overall inhibition (K_i) was performed on each of these inhibitors. These inhibitors showed rapid onset of inhibition (k_{on} of 10^2 to 10^4 $M^{-1}s^{-1}$), slow reversal (k_{off} of 10^{-3} to 10^{-4} s^{-1}) and had K_i values in the range of 10 to 100 nM. The kinetic parameters of these compounds are comparable to those of compound **1**. No significant activity against MMP-1, MMP-3, and MMP-7 was observed. These results indicate that these compounds show promise as potent and selective inhibitors of gelatinases. One of these compounds (compound **2**) contains a functional group that can be capitalized in a prodrug strategy to improve the aqueous solubility and pharmacokienetic properties of the gelatinase inhibitors.



1 (R = OSO_2CH_3); 2 (R= NH_2)

What inspired you to participate in undergraduate research?
I wanted to apply the skills that I learned in the laboratory sections of my chemistry classes to a bigger picture. I really like the idea that the work I do as an undergraduate researcher can actually contribute to the lab and the scientific community in general.

How did you get your research position, and what preparation did you undertake for it?
I joined the Mobashery lab in January of 2009 during my junior year. I decided to continue working on my project over the summer and received funding from the College of Science Summer Undergraduate Research Fellowship.

Where was your research experience located?
University of Notre Dame

What did you get out of your research experience?
This experience has encouraged me to pursue scientific research in the future throughout my time in medical school. My project also required me to read through several scientific papers and books, which sharpened my data retrieval and scientific reading comprehension skills. Overall, this experience gave me a good idea of what scientific research really involves and allowed me to show myself how much I am capable of.

POSTER PRESENTATIONS

Effects of Competition and Predation on the Feeding Rate of the Freshwater Snail **Helisoma trivolvis**

Shayna Sura
Major: Environmental Science
Advisor: Heidi K. Mahon, Department of Biological Sciences

Foraging behavior of snails is affected by competition and risk of predation, which can be detected by chemical cues in the water. Freshwater snails are able to detect and respond to kairomones, from predators, and chemical cues, such as alarm cues, from other snails. Invasive species, such as the Chinese mystery snail, are known to affect native species through processes such as competition and predation. This study examines the effects of various competition and predation risks on the feeding rate of *Helisoma trivolvis*. Higher densities of competition cause the snails to increase their feeding rate compared to no competition and low densities. Presence of crayfish causes the snails to decrease their feeding rate and it masks the effects on density and type of competition on the feeding rate. There is no significant difference in feeding rates for the different treatments between the predation and crushed snails experiments, suggesting kairomones are more influential than alarm cues in altering foraging behavior. Despite significant effects of Chinese mystery snails on the feeding rate of *H. trivolvis*, the invasion of Chinese mystery snails is likely to alter the community structure by consuming more algae and possibly increasing the feeding rate of native snails.

What inspired you to participate in undergraduate research?
I enjoy trying to figure out and understand how organisms interact with each other and their environment. Also, it is great experience to have when applying to graduate schools.

How did you get your research position, and what preparation did you undertake for it?
I heard about the UNDERC program when I visited Notre Dame campus and made it my goal to participate in the program. During the fall of my sophomore year, I applied to the program and was accepted. I had prior research experience as an REU and working in a lab, which helped me get accepted into the program.

Where was your research experience located?
University of Notre Dame Environmental Research Center (UNDERC) East located in Northern Wisconsin.

What did you get out of your research experience?
I had a summer filled with adventures, fun, and new experiences. Besides learning how to design an experiment, conduct it, and write up and present my results, I was delighted in having finished a successful experiment by the end of the summer. Overall, UNDERC was a rewarding experience and I came away with new friends and great resources for the future.

Coronary Heart Disease Risk Factors Influence on Ten Year Risk

Zachary Townsend
Major: Science Pre-Professional
Advisors: Bill Spears, Community Health and Pediatrics, Center for Healthy Communities,
and Gordana Gataric, Department of Geriatrics,
Wright State University Boonshoft School of Medicine

Coronary heart disease (CHD) is the leading cause of death in the U.S. Characterized by long-term atherosclerosis or hardening of the arteries, CHD can lead to intermittent claudication, myocardial infarction, or atherothrombotic stroke. Factors that impact CHD include both inherited and modifiable risk. Health screenings are effective tools for estimating coronary heart disease from known risk factors. This study investigates the prevalence of risk factors and the 10 year risk of CHD from 5,937 health screenings offered by Premier Community Health (PCH) in the Greater Dayton Area from July 2008 to June 2009. PCH is a community based organization that offers CVD screenings at health fairs, churches, and in the community and then conducts follow-ups on high risk participants. The estimated 10 year CHD risk (adapted from the Framingham Risk Score) is based on blood pressure, total cholesterol, blood lipid levels, tobacco use and presence of diabetes. Predictive Analytics Soft Ware (PASW) statistics were used to analyze data obtained from screenings. Findings from the coronary heart disease screening data show that age is a major contributing factor for the level of risk from risk factors. As the participants' age increased, the prevalence of high-very high risk factors increased. Because of this, progressing age also increased the 10 year risk for coronary heart disease. Thus, our results suggest that implementing age-specific strategies for early prevention limiting the effect of modifiable lifestyle risk factors for CHD will decrease the prevalence of CHD in the 55 and older population.

What inspired you to participate in undergraduate research?
I always enjoyed my lab classes, but I felt that I didn't have enough experience in research. This program offered the opportunity to work one-on-one with a researcher in a field of my choosing.

How did you get your research position, and what preparation did you undertake for it?
I applied to Wright State University's Short-Term Training Program to Increase Diversity in Health-Related Research (STREAMS). The program required some research experience, but its goal was to encourage biomedical research. In preparation for my research I took both human subject training and animal subject training. I was paired with two mentors who were studying coronary heart disease and follow-ups after health screenings. The research was funded by NIA Grant HL0078805.

Where was your research experience located?
Wright State University Boonshoft School of Medicine, Dayton, Ohio

What did you get out of your research experience?
I met many friends, who shared their interest and experiences in research with me. I also gained an appreciation for public health research. With the help of my mentors, I learned that research on humans is important in predicting trends in populations but requires sufficient data analysis to estimate trends.

POSTER PRESENTATIONS

The Origin of the S100 Proteins and their Role in Inflammation in Systemic Juvenile Idiopathic Arthritis

Amanda Zofkie
Major: Science-Business
Advisor: Alexei Grom,
Department of Rheumatology, Cincinnati Children's Hospital

Systemic Juvenile Idiopathic Arthritis (sJIA) is a subtype of juvenile arthritis affecting children who are less than 16 years of age presenting with a spiking quotidian fever, as well as a characteristic rash, and persistent joint pain for more than two weeks. The S100 proteins are a group of calcium-binding proteins that have been found to mediate the inflammatory response. Recent studies show that three specific S100 proteins, S100A8, S100A9, and S100A12 have been detected in dramatically increased amounts in the synovial fluid and serum of systemic juvenile arthritis patients. These three proteins are an important marker for inflammation in sJIA and in the future may be used as a clinical implication that a patient in fact has sJIA. The objective of this study was to confirm that these S100 proteins are increased in sJIA patients as compared to other juvenile arthritis patients and normal, healthy controls, and to determine the serial cellular source of these three S100 proteins. Correlation analysis was conducted with ELISA protein levels of 177 juvenile arthritis patients' serum for all 7 juvenile arthritis subtypes and normal, healthy controls. S100 mRNA levels were analyzed in three different treated and untreated cell types (PBMCs, monocytes, and neutrophils) using PCR. ELISA data shows a dramatic increase in the S100 proteins in sJIA patients as compared to the other 6 subtypes of juvenile arthritis, as well as healthy controls. Our data also shows that S100 mRNA is present in PBMCs, monocytes, and neutrophils that have been activated, or left untreated based on PCR data, and our lab hypothesizes that M2 macrophages are the cellular source of these proteins.

What inspired you to participate in undergraduate research?

I have worked in my lab at Notre Dame with Dr. Robert Stahelin since the beginning of my junior year and I have enjoyed it immensely. I decided to apply to the Summer Undergraduate Research Fellowship in Rheumatology at Cincinnati Children's Hospital to learn more about juvenile arthritis.

How did you get your research position, and what preparation did you undertake for it?

I applied online to the SURF program at Cincinnati Children's and I had to write several essays about my previous research experience, reasons for applying, and research departments I was interested in. I prepared for this position by researching rheumatic conditions and current research about these conditions.

Where was your research experience located?

Cincinnati Children's Hospital and Medical Center

What did you get out of your research experience?

I learned several different laboratory techniques such as PCR, agarose gel preparation, real-time PCR, and mRNA purification. I met many interesting colleagues from different countries and I enjoyed working with them immensely. I also was able to shadow in the rheumatology clinic and experience juvenile arthritis on a first-hand basis.

ORAL PRESENTATIONS II

Ascorbic Acid (Vitamin C) Selectively Kills Cancer Cells and Enhances the Efficacy of Chemotherapy Drugs in vitro

Brian Chalmers
Major: Science-Business
Mentor: Qi Chen,
Department of Pharmacology and Toxicology, University of Kansas Medical Center

Human cancer is the second leading cause of death in the United States. Pancreatic cancer is an especially aggressive cancer and those diagnosed with the disease have a 5% 5-year survival rate. The efficacy of vitamin C as an anticancer drug has been a topic for debate for decades as it is traditionally viewed as an antioxidant. In this experiment, sixteen unique cancer cells lines were treated with pharmacological doses of ascorbic acid *in vitro* and cell survival was measured with MTT assays in order to determine the cytotoxicity of cancer cells. Subtoxic doses of vitamin C were also applied over different time intervals to Pan 02 pancreatic cancer cells in order to determine ascorbic acid's ability to slow the migration of this aggressive cancer. To explore the interaction between ascorbic acid and chemotherapy agents, physiological and pharmacological concentrations of ascorbic acid were combined with various doses of gemcitabine, the front-line anticancer drug for pancreatic cancer, *in vitro* and cell survival was again measured with MTT assays. Ascorbic acid also slowed the migration of Pan 02 cells. Fifteen of the sixteen cancer cells lines tested were highly sensitive to pharmacological doses of ascorbic acid. Physiological doses of ascorbic acid did not interfere with chemotherapy treatments *in vitro* and pharmacological doses showed synergy with gemcitabine in Pan 02, Panc 1, and Mia-PaCa-2 cells. Ongoing *in vivo* studies are being conducted to further explore the benefits of the synergistic relationship between chemotherapy agents and ascorbic acid.

What inspired you to participate in undergraduate research?
Working independently to discover new science that no one else has is exciting and satisfies my curiosity and love of science.

How did you get your research position and what preparation did you undertake for it?
I found the program on the internet since I wanted to remain in Kansas City for the summer. The program was the American Society for Pharmacology and Experimental Therapeutics (ASPET) Summer Undergraduate Research Fellowship (SURF). ASPET and the University of Kansas Medical Center funded the ten week research experience. I had to do little to prepare for the internship except apply, sending in my resume, an application, and two letters of recommendation.

Where was your research located?
University of Kansas Medical Center's Department of Pharmacology, Toxicology, and Experimental Therapeutics in Kansas City, Kansas.

What did you get out of your research experience?
I greatly expanded my laboratory skills and ability to research specific articles and topics. Given much independence to design my own experiments, I learned the value of careful research and planning beforehand. My research will hopefully be included in the lab's next publication. I met intelligent and friendly people with whom I will work with again next summer.

The Thue-Morse Sequence on Exponential Subsequences

Bethany Herwaldt
Major: Mathematics
Advisor: A.J. Hildebrand
Department of Mathematics, University of Illinois

The Thue-Morse sequence $\{t(n)\}$ is the binary sequence defined by $t(n)=1$ if n has an even number of 1's in its binary expansion, and $t(n)=-1$ if n has an odd number of 1's in its binary expansion. This sequence arises naturally in many areas of mathematics and other subjects. It has been extensively studied in the literature, yet much of its behavior remains mysterious. In particular, its behavior on subsequences (e.g., arithmetic progressions, squares, or primes) leads to interesting and largely unsolved problems. Given such a subsequence, one can ask to what extent the Thue-Morse sequence behaves like a random ±1 sequence when restricted to this subsequence. For example, are the proportions of values $+1$ and -1 on the subsequence asymptotically the same?

Our computations indicate that on the sequence $\{3^n\} and most other exponentially growing sequences, the Thue-Morse sequence behaves like a random ±1 sequence. The graphs of the partial sums of these sequences are indistinguishable from those generated by a corresponding random simulation. Moreover, a histogram of the partial sums of the first $10,000$ terms, computed for a family of $10,000$ second order recurrence sequences a_n , has the “bell curve” shape typical of the distribution of a sum of $10,000$ independent ±1 terms.

What inspired you to participate in undergraduate research?

I love approaching unsolved problems and not knowing right away how to solve them. After reading about the mathematician Paul Erdos and taking a class in number theory, I was especially interested in trying some number theory research.

How did you get your research position, and what preparation did you undertake for it?

The NSF funds REU (Research Experience for Undergraduates) programs around the country each summer. I applied to some of these programs and was accepted. My mathematics and computer science courses helped to prepare me.

Where was your research experience located?

University of Illinois - Champaign-Urbana

What did you get out of your research experience?

I was able to explore another area of mathematics, which will help me make decisions about graduate school. I also improved such skills as programming and writing in LaTeX. We had many extra events, such as tours, talks, and seminars, that helped me broaden my base of mathematical knowledge.

Defining Cosmological Voids in the Millennium Simulation Using the Parameter-free ZOBOV Algorithm

Frances Mei Hardin
Major: Biochemistry
Advisor: Peter Garnavich, Department of Physics

The Zones Bordering On Voidness (ZOBOV) parameter-free void-finding algorithm is applied to data from the 2005 *N*-body Millennium Simulation. Voids can be used as a distance estimator for cosmic expansion to the first order because they are affected by only dark matter and relatively small quantities of real matter. They are defined within the ZOBOV program as local density minima and their surrounding depressions fixed by Voronoi tessellations. The return from ZOBOV's analysis of the Millennium data depicts the probabilities of voids from Poisson fluctuations instead of assigning parameters to automatically choose a set of voids because there currently is no conventional statistical significance level across void-finding algorithms in astrophysics. Designating a significance level allows for specificity of output voids but overall significance levels vary depending on the goals of the experiment. The voids defined by the ZOBOV program in this paper have a default density threshold of 0.2 so that voids with minimum density greater than 0.2 times the mean density are excluded. Successful results were obtained by running ZOBOV with 58,715 voids found within the full, 9 million particle data set, 6,451 voids found within ~1 million particles, 1,884 voids found within ~300,000 particles, and 483 voids found within ~80,000 particles.

What inspired you to participate in undergraduate research?
My experience at Fermilab National Accelerator Laboratory in the Dark Energy Survey during the 2007-2008 academic year led to my interest in astrophysics, and discussing a variety of areas within the discipline of astrophysics with Dr. Garnavich in the fall of 2008 led to the specificity of my interest in voids and computational astrophysics.

How did you get your research position, and what preparation did you undertake for it?
After meeting with Dr. Garnavich each week during the fall semester of 2008, I began researching the topic of voids in January 2009 and I submitted an application to the University of Notre Dame Physics REU for the summer.

Where was your research experience located?
University of Notre Dame

What did you get out of your research experience?
I was able to spend ten beautiful, serene weeks at Notre Dame over the summer, meet students from universities around the country, and travel to the Vatican Observatory (AZ) to collect live data for a week! I learned fundamentals for three computing languages, how to apply concepts to raw data, and about science ethics through REU seminars. My research experience also provided a strong foundation for graduate school because of the intensive work and informative nature of the work.

Alpha-2 Adrenergic Agonists Clonidine and P-Aminoclonidine for the Prevention and Treatment of Enterotoxigenic and Viral Diarrheal Diseases

Bill Flavin
Major: Biochemistry
Advisors: Eugene B. Chang, Mark W. Musch
Biological Sciences Division, University of Chicago

Diarrheal diseases caused by intestinal pathogens rank third among the leading causes of infection-related mortality reported by the WHO burden of disease report (2002). While effective measures to restore metabolic and fluid losses are available after the onset of disease, there are no specific or practical medical measures to reduce the risk of acquiring these diseases. To that end, a class of compounds similar to adrenaline, the alpha-2 adrenergic agonists, were examined as potential anti-diarrheal agents. Some of these agents have been effective in preventing and reversing water and electrolyte secretion in the intestine stimulated by agents that specifically activate cellular pathways that are used by bacterial toxins and viruses. However, for some of the most effective agents, unwanted side-effects have limited their potential for use in treating patients afflicted with secretory diarrhea. Clonidine has been shown to prevent and reverse the net secretory responses stimulated by increases in cyclic nucleotides and cytosolic calcium caused by enteric pathogens when localized to the small bowel, but because of its use as an FDA-approved antihypertensive agent, administration of clonidine also causes an undesirable decrease in blood pressure. Because of this, a distinct analog called p-aminoclonidine (PAC) was tested alongside clonidine using a well-described technique to measure intestinal water and electrolyte transport in an effort to increase the polarity of the clonidine motif so as to limit its passage across the blood-brain barrier, preventing its antihypertensive side-effects while maintaining its potency in the gut. In the future, the ability of these agents to directly prevent or inhibit diarrhea stimulated by agents that cause cholera, viral, and travelers' diarrhea can be explored in greater depth. If these agents prove effective in prevention or treatment of infectious diarrheas, they can be further developed as compounds that can be used to lower the risk or consequences of global diarrheal diseases.

What inspired you to participate in undergraduate research?

I am very interested in the pharmaceutical industry and drug development because it seems like a very practical way to leverage my interest in science towards improving the health of people afflicted with disease. In my undergraduate research experience, I had the opportunity to work alongside experts in the field who also cared for patients in the clinic, so it was a great way for me to see the impact of my laboratory work 'from the bench to the bedside'.

How did you get your research position, and what preparation did you undertake for it?

After participating in some introductory chemistry laboratory work in the summer of 2007, I was invited to begin an internship in the Martin Boyer Laboratories at the University of Chicago Medical Center for the summer of 2008. In the spring prior, I worked with my advisor to submit a grant proposal to the American Physiological Society. After my first summer of learning a variety of new techniques, participating in lab meetings, and shadowing doctors around the clinic, I had the opportunity to return to the U of C in the summer of 2009 to continue work on my project. For this work, I submitted a grant proposal to the American Gastroenterological Association, and by the end of the summer, I was able to accumulate a reasonable amount of promising data on my topic of interest. Each summer's experience built on the one prior, but my science courses and laboratory experience at Notre Dame prepared me well for my independent project in the summer.

Where was your research experience located?

The University of Chicago

What did you get out of your research experience?

A fun and exciting summer at the University of Chicago, new friends, and wonderful new mentors! I learned fascinating research techniques, strategies, and perspectives that will be invaluable to me as I continue in my education and research.

DNA barcoding parasite organisms found in terrestrial mammal scat using COI sequence data

Derryl Miller
Major: Biochemistry and Math
Advisor: Andy Mahon, Department of Biological Sciences

While invasive techniques such as trapping or marking animals for study are a concern for the safety and preservation of established ecosystems, molecular techniques have provided accurate information about population dynamics and the interaction between many species within an ecosystem, oftentimes without unnecessary human interaction. Molecular techniques, involving the sequencing of mitochondrial DNA such as the Cytochrome c Oxidase subunit I (COI), are extremely versatile in the study of invasive, endangered, and evasive or dangerous species. This is possible because the COI is a relatively short strand of DNA which can be found in scat, hair, tissue, and virtually anywhere where target organisms shed cells. This study focuses on the barcoding of parasites found in the scat of terrestrial mammals at the University of Notre Dame Environmental Research Center (UNDERC). From the sequencing and analysis of numerous organisms and the generation of a phylogenic tree, this work finds that even a fragment of the COI gene can be effective for the analysis of both identity of a specimen and the relatedness between specimens (Bayesian statistic > 0.5 for numerous groups) found at UNDERC with the help of additional sequence data from the National Center for Biotechnology Information (NCBI) database.

What inspired you to participate in undergraduate research?
I was especially drawn to the UNDERC program because of its unique fusion of laboratory work with collection of samples in the wilderness. It was a lot of fun to make the great outdoors a laboratory for the discovery of real world models.

How did you get your research position, and what preparation did you undertake for it?
I had been working in undergraduate research with the Lappin group for the 08-09 school year, but I wanted to change direction and try some biological research that would incorporate biological questions through a more chemical and environmental interest. Molecular Biology research is what I found, and I will be continuing this research in the Lodge Lab this semester. UNDERC is funded through the generosity of the Hank Family Endowment, and researchers are selected based on an application process through the Biology Department.

Where was your research experience located?
The University of Notre Dame's 7800 acres of land located near Land O' Lakes, WI.

What did you get out of your research experience?
I got a summer of fun and adventure, while meeting lots of new friends and learning a lot about molecular biology, which I knew very little about prior to this experience. UNDERC is also a great program for learning to better appreciate the work that goes into environmental research projects. This will hopefully provide me with the tools to pursue future study of populations through DNA barcoding in the Lodge Lab.

ORAL PRESENTATIONS II

C1q enhances phagocytosis of Mycobacterium avium through a pertussis toxin sensitive pathway

Kristen Ploetze
Major: Biological Sciences
Advisor: Suzanne Bohlson, Department of Biological Sciences,
Department of Microbiology and Immunology, Indiana University School of Medicine-South Bend

The mycobacteria are intracellular pathogens, relying on efficient entry into the host macrophage to establish and sustain an infection. C1q and MBL are members of a family of pattern recognition molecules called defense collagens, known to bind to certain pathogens, as well as apoptotic cells and trigger an enhancement of phagocytic activity. C1q and MBL also trigger a dampening of proinflammatory cytokine production and an upregulation of anti-inflammatory IL-10 from human monocytes. A concurrent enhancement of phagocytosis of apoptotic cells and diminution of proinflammatory cytokine production by defense collagens would be beneficial in clearance of apoptotic cells; a process that occurs normally in the absence of inflammation. However, during uptake of mycobacteria, defense collagen triggered phagocytosis and dampening of proinflammatory cytokine production may be beneficial to the pathogen. Here we demonstrate that C1q triggered an enhancement of phagocytosis of *Mycobacterium avium* from mouse bone marrow derived macrophages (BMDM). TNF-alpha production was reduced from BMDM exposed to C1q-opsonized mycobacteria despite the higher levels of phagocytosis. C1q-mediated enhanced phagocytosis was sensitive to pertussis toxin (PTx), implicating a G-protein coupled receptor (GPCR) is essential to the process. PTx inhibited C1q-enhanced ingestion of *M. avium* when macrophages were adherent to C1q and when C1q was used to opsonize the mycobacteria. In addition, BMDM adherent to C1q displayed an average 4.4-fold enhancement of Fc-receptor mediated phagocytosis which was inhibited with PTx. Importantly, fibronectin mediated enhanced phagocytosis was insensitive to PTx demonstrating that PTx is not a global inhibitor of phagocyte function. Similar results were observed from human monocytes. These data suggest that mycobacteria, similar to apoptotic cells, utilize defense collagens to promote rapid ingestion in the absence of inflammation and for the first time implicate a GPCR dependent pathway in defense collagen triggered phagocytosis.

What inspired you to participate in undergraduate research?
I wanted to challenge myself more in my study of biology by undertaking an independent study research project. During that project I captured the fire that comes with the discovery of new information, which inspired me to join a research lab on campus.

How did you get your research position, and what preparation did you undertake for it?
I applied to work as undergraduate research assistant in Dr. Bohlson's lab at the end of my sophomore year. I had just completed my independent study project in cell biology, so I was equipped with the technical skill and experience enabling me to contribute to the lab right away.

Where was your research experience located?
University of Notre Dame/Indiana University School of Medicine—South Bend

What did you get out of your research experience?
My research experience has been a great supplement to my education at Notre Dame. Through my research experience, I am able to explore studies I'm interested in beyond what is provided in the textbook.