FALL UNDERGRADUATE RESEARCH FAIR

THURSDAY, OCTOBER 31, 6:00-9:00 P.M. - JORDAN HALL OF SCIENCE

UNIVERSITY OF NOTRE DAME
College of Science

College of Science – Fall Undergraduate Research Fair 2013

Welcome!

The purpose of this event is to provide science students with an opportunity to get many of their questions answered about undergraduate research. Not only about how to get more involved in research, but also how to get more out of the research experience itself.

Throughout and beyond the College of Science there are many different ways in which students can get involved in research. Often it's just a question of looking in the right places and being persistent in the hunt for the right opportunity. However, getting the right opportunity is also about getting as much information as possible from a diversity of sources. This could be as simple as a fellow student but there are also many organizations, institutes, and centers on campus that are also more than willing to help a student find and support their research endeavors. Furthermore, there are many ways for students to get even more out of their research experience, through publishing and presenting their research to their peers.

Through a combination of listening to speakers, poster presenters, and representatives from various institutions, students should be able to get some ideas about how best to get started looking for research opportunities. Also, students should be able to see how they can add value to their research experience by participating in other related activities. The sooner a student begins the search, the sooner they will be able to start participating in undergraduate research and getting the most from that experience!

Schedule and Table of Contents

Undergraduate Research Internships Information Night - Jordan 101

Organizer - Mark Olsen (olsen.2@nd.edu)

6:00 - 6:05	Introductions
6:05 - 6:20	Rachel Cotton, National Institutes of Health
6:20 - 6:30	Jeffrey Hansen, University of Virginia Medical School
6:30 - 6:40	Joseph Mueller, Mote Marine Laboratory
6:40 - 6:50	Stephanie Terpening, Stem CentRx
8:50 - 9:00	Questions and Answers

Speaker Biographies

Rachel Cotton (Plenary Speaker, rcotton1@nd.edu) Class Year: 2014

I'm a senior Biological Sciences major living in Breen Phillips Hall. I've worked in Mary Ann McDowell's lab in the Eck Institute for Global Health since fall of my freshman year, where study the immunobiology of leishmania infection. I did and NSF-REU program at Washington University in St. Louis the summer after my freshman year, where I worked on the role of chemokines in osteoarthritis pathogenesis. I've spent the past two summers in the Laboratory of Parasitic Diseases at the NIH, studying immune modulation mechanisms in lymphatic filariasis. Between my time at Notre Dame and the NIH, I've authored or coauthored 4 manuscripts that are either published or in review, and have presented at numerous international meetings, including one in Sao Paulo, Brazil. I TA for Genetics lab, am the Co-Editor in Chief of Scientia, and I created a new Science Policy Ethics course now offered each spring. Outside of the College of Science (the best college at Notre Dame), I'm on the Notre Dame Ski and Snowboard team. I'm currently applying to Immunology PhD programs.

Jeff Hansen (jhansen5@nd.edu) Class Year: 2015

I am a junior Biology major here at Notre Dame. I am working my way towards applying to MD/PhD programs next summer and hope to eventually use this degree to research towards the cure of type 1 diabetes and conduct clinical work relating to the field of type 1 diabetes. Here at Notre Dame, I have been researching population genetics and disease ecology in the lab of Dr. Elizabeth Archie; this is my third year in her lab. My past two summers have been spent at the University of Virginia on grants from the College of Science and the Center for Undergraduate Scholarly Engagement, researching biomarkers for type 1diabetes. Finally, this year I am a teaching assistant for Intro Biology Lab courses taught by Dr. Mark Olsen. Please contact me with questions about the benefits of MD/PhD programs, about receiving funding from Notre Dame, or about finding opportunities to do summer research.

Joseph Mueller (jmuell10@nd.edu) Class Year: 2016

Internship Program Name: NSF Research Experience for Undergraduates at Mote Marine Laboratory, Sarasota, FL Summer 2013 Brief Description: Studied the antimicrobial compounds produced by bacterial symbionts of the epidermal mucus of the Cownose Stingray and Devil Ray for potential use in human antibiotics.

Stephanie Terpening (sterpeni@nd.edu) Class Year: 2016

I am a sophomore (class of 2016) and I worked at Stem CentRx (a biotech company) in San Francisco, California. I worked this past summer from May until August with the company and am going back over Christmas to do some more research with them. Although I cannot tell you the exact project I was working on due to confidentiality agreements, the basis of what I was involved in was looking at potential markers that could bind to cancer stem cells. I did this in all different types of solid tumors--ovarian, kidney, lung, colon, liver, breast, skin, etc--using flow cytometry. If a marker was found, an antibody drug conjugate (ADC) was synthesized to target the cancer stem cell and destroy it using a toxin attached to the ADC.
http://www.stemcentrx.com/

Information Tables - Jordan Galleria

Career Center (careercenter.nd.edu)

The Career Center offers resources for all students including ideas on searching for an internship or job, tips on writing your resume and cover letters, and contacting and networking with Notre Dame alums and others. Lists of past internships at which science students have participated and hints on making a successful internship connection are also available. Workshops on the Internship Search for Science Students will be held monthly from October through January, so watch for details and attend one of these informative sessions.

Contact: Laura Flynn (lflynn@nd.edu), Science and Engineering Career Counselor.

Center for Nano Science and Technology (nano.nd.edu)

The University of Notre Dame¹s Center for Nano Science and Technology (NDnano) is one of the leading nanotechnology centers in the world. Our mission is to understand how to manipulate and control the properties of materials, devices and their interface to living systems at the nanoscale. With this knowledge, we aim to be a force for good. Each year, NDnano awards several paid fellowships to undergrad students who spend 10 weeks of their summer engaged in a research project, mentored by an Ndnano faculty member in science or engineering. Summer 2014 will mark the NURF program's sixth year. To date, nearly 150 students from Notre Dame and several other universities have participated in the program, gaining valuable skills and experience. The 2014 application process will open the first day of classes in January. Meet the 2013 NURF recipients and learn about their projects at www3.nd.edu/~ndnano/education/2013_NURF_projects_summaries.html

Contact: Heidi Deethardt (deethardt.1@nd.edu), Administrative Assistant

Center for Research Computing (crc.nd.edu)

The Notre Dame's Center for Research Computing (CRC, crc.nd.edu), a joint effort of Notre Dame's Offices of Vice President of Research (OVPR) and Information Technologies (OIT) and Notre Dame Colleges, supports the research agenda of the University through high availability of managed computing assets and research and engineering staff with expertise in the application of these resources to multi-disciplinary research interests. CRC is a unique, interdisciplinary environment, where strong groups of computational and computer scientists and research programmers work side by side with scientists, engineers, mathematicians and scholars in the arts, humanities, and business and economics to create new information technology approaches to research. The CRC, with forty staff and faculty members, is today a major research and research support enterprise that is anxious to work with undergraduate students.

Contact: Kallie O'Connell (Kallie.A.O'Connell.69@nd.edu), Coordinator.

Center for Sustainable Energy at Notre Dame (cSEND, energy.nd.edu)

The Center for Sustainable Energy at Notre Dame is a University Research Center whose mission is to advance innovative energy related research, education and outreach programs to

address the global challenges of creating a more sustainable energy future for all. cSEND is built upon the foundations laid by the Notre Dame Energy Center (a College of Engineering research center, initiated in 2005) and the Sustainable Energy Initiative (a Strategic Research Investment, funded by the University in 2010). A high priority for cSEND is to engage undergraduate students in energy related research and education. This is accomplished through the administration of the Vincent P. Slatt Fellowships for Undergraduate Research in Energy Systems and Processes and the Energy Studies Minor. Both programs help to prepare undergraduate students to become successful researchers and leaders who create better energy systems and devices and understand the complexities of society's energy challenges.

Contact: Barbara Villarosa (villarosa.2@nd.edu), Administrative Services Program Manager.

Center for Undergraduate Scholarly Engagement (CUSE, cuse.nd.edu)

CUSE has a mission to promote the intellectual engagement of Notre Dame students through (1) creating opportunities for undergraduate research, scholarship, and creative endeavors in all colleges by connecting students to resources such as faculty mentors, projects, funding, and venues for presenting and publishing their work undergraduate research and (2) encouraging and facilitating applications for national fellowships like the Rhodes Scholarship, the National Science Foundation Graduate Research Fellowship, the Truman Scholarship, and the Goldwater Scholarship.

Contacts: Dr. Darlene Hampton (urnd@nd.edu), Assistant Director of Undergraduate Research, and Dr. Jeffrey Thibert (fellows@nd.edu), Assistant Director of National Fellowships.

Engineering, Science and Technology Entrepreneurship Excellence Master's Program

The University of Notre Dame's ESTEEM Program is a 1-year Master of Science Program developed as a joint program of the College of Science, College of Engineering and Mendoza College of Business. ESTEEM is designed to provide Science and Engineering graduates the skills required to take science and/or engineering inventions and translate those inventions into commercial ventures while strengthening their science and/or engineering skills.

The innovative curriculum requires 12 credit hours of customized commercial courses covering such topics as finance, marketing, strategy, leadership, supply chain, project management, quality, operations research, ethics and advanced financial topics. These courses have been constructed to specifically meet the needs of ESTEEM students. There are also six credit hours of science and/or engineering electives required to deepen the ESTEEM student's technical foundation.

Contact: David Murphy (dmurph12@nd.edu), Director.

The First Year of Studies (fys.nd.edu)

First Year of Studies (FYS) supports and promotes research in two ways. First, through Research Ignition Fellowships, for which FYS can award up to $1500 ($1000 for travel/meals/living, $500 for materials to current first year students to conduct research or present at a conference during their first year or summer between freshman and sophomore years. Second, through a one-credit

class (FYS 10406 Introduction to the Research Process) which is offered during the spring semester as a way to help current first year students understand how the research process works to better prepare them for possible research opportunities during their time at Notre Dame.

Contact: Sean Wernert (Sean.P.Wernert.1@nd.edu), Advisor.

Harper Cancer Research Institute (harpercancer.nd.edu)

Investigators in the Harper Cancer Research Institute (HCRI) are dedicated to conducting innovative and integrative basic and clinical research that confronts the complex challenges of cancer. Our programmatic structure fosters multi-disciplinary cancer research by promoting interactions among research groups with distinct expertise and by training young scientists to work across scientific fields. Clinical partnerships provide key translational insight and strengthen the mission of discovery. HCRI is facilitating collaborations between faculty in the College of Science, College of Engineering, College of Arts and Letters, and the Indiana University School of Medicine - South Bend. Some of the research projects currently taking place on campus involve using nanotechnology to better target chemotherapeutics, searching for new cancer markers and targets, and developing less expensive and more accurate diagnostics.

Contact: Angela Cavalieri (cavalieri.2@nd.ed), Administrative Coordinator.

Hesburgh Library (library.nd.edu)

The Hesburgh Libraries system includes the main Hesburgh Library, as well as the O'Meara Mathematics Library in Hayes-Healy, the Engineering Library in Fitzpatrick, the Chemistry-Physics Library in Nieuwland, the Mahaffey Business Library in Mendoza, and the Architecture Library in Bond Hall. There is also the new Center for Digital Scholarship, https://library.nd.edu/cds/. The Libraries provide critical support for your research, including access to thousands of online databases, journals, DVDs, books, maps and more. Librarians are prepared to assist you with your research by providing individual research consultations, or through a variety of library workshops and in-class instructional sessions. There's also the Library's Undergraduate Research Award, http://guides.library.nd.edu/subject-guide/77-2012-Undergraduate-Library-Research-Award. To contact your subject librarian use http://library.nd.edu/directory/subjects or the Ask-A-Librarian service at http://asklib.nd.edu/. Register for a workshops at http://library.nd.edu/instruction/workshops.shtml.

Contacts: Parker Ladwig (ladwig.1@nd.edu), Mathematics and Life Sciences Librarian; Thurston Miller (miller.115@nd.edu), Chemistry and Physics Librarian; Carol Brach (brach.10@nd.edu), Engineering Librarian; Laura Bayard (bayard.1@nd.edu), Undergraduate Outreach Services Librarian.

Indiana University School of Medicine – South Bend (medicine.iu.edu/southbend)

Indiana University School of Medicine South Bend (IUSM SB) is a regional campus of the Indiana University School of Medicine. This four-year regional campus, located on the corner of Angela Blvd. and Notre Dame Avenue across from the main entrance to the Notre Dame (ND) campus, offers research opportunities for undergraduates in the basic sciences, Biology,

Chemistry, and Biochemistry with an emphasis on medically related research projects in cancer, infectious disease, and neurosciences. The research programs are led by IUSM SB faculty members who have adjunct ND faculty positions and consist of ND undergraduates, ND graduate students, and IUSM SB post-doctoral fellows and technical staff. Information on research opportunities and the various laboratories can be found at medicine.iu.edu/southbend/.

Contact: Dr. Rudolph Navari (rnavari@nd.edu), Director and Professor.

Innovation Park at Notre Dame (www.innovationparknd.com)

The mission of Innovation Park at Notre Dame is to cultivate marketable innovations in an inspiring environment, with access to Notre Dame's cutting-edge research, world-class students and faculty, and the global network of ND alumni and friends. Innovation Park provides not only Class A space and amenities for its client-tenant companies on a 24/7 basis, but also business development consultation services. These services frequently involve reaching out to the ND alumni base for expert advice on client issues. As client companies are typically very early stage ventures, this affords every member of the team, including student-interns, to take an active role in the commercial development of the business. Since opening in late 2009 scores of ND students have interned with client companies, and several have received formal job offers following graduation. In all cases the experience of being part of a new business commercialization team provides the student-intern with first-hand knowledge and skills that will benefit the student's eventual career choice, either in a new or existing business. For more information on the Park and its clients, check out www.innovationparknd.com

Contact: David Brenner (dbrenner@innovationparknd.com, Executive Director, or Natalie Gunn-Stahl (nstahl@innovationparknd.com), Facility Manager.

Institute for Scholarship in the Liberal Arts (ISLA, isla.nd.edu)

The Undergraduate Research Opportunity Program (UROP) provides grants to students who wish to pursue independent research or creative projects. The UROP program, which is open to any student pursuing a major or a minor in the College of Arts and Letters, offers four major types of grant: the Conference Presentation Grant; the Research and Materials Grant; the Senior Thesis Grant; and the Summer Grant. Students who wish to apply must submit a proposal, budget and a letter of recommendation to urapply.nd.edu.

Together with the College of Science, UROP also offers Science, Arts and Letters, and Engineering students Summer Grants for those students who wish to engage in research or creative projects that cross the traditional boundaries between the sciences and the liberal arts. These grants are open to College of Science/Arts and Letters double majors as well as those students who have a minor in the College of Arts and Letters.

Contact: Dr. Karla Cruise (kcruise@nd.edu), Assistant Director.

International Studies Office (international.nd.edu/international-studies/)

The International Studies Office offers scientific research opportunities at various partner Universities within the study abroad programs. Research is available in the Dublin UCD, Ireland

and Perth, Australia programs. Students are introduced to the principles of scientific research by participating in an active research group, conducting independent research into scientific literature and shadowing a member of the research team in the laboratory. They will design experiments and learn to write a scientific abstract.

ND's Research Experiences for Undergraduates (REU) Program provides five summer research opportunities in Ireland in a STEM ten week program. In recent years, it has been extended to Irish Universities, under the auspices of the Naughton Fellows Committee. Projects are in conjunction with University College Cork, Dublin City University, and Trinity College Dublin.

Other science research projects sponsored during study abroad semesters include individual research projects at the Chinese University of Hong Kong and at the Pontifical University of Chile in Santiago. Similarly, Physics students have the opportunity to participate in a directed research program in Geneva, Switzerland at the CERN during spring semester in addition to other courses takes at the University of Geneva.

Contact: Kathleen Opel (kopel@nd.edu), Director.

Museum of Biodiversity (science.nd.edu/jordan/about/museum-of-biodiversity.shtml)

The Museum of Biodiversity, located near the northern end of Jordan Hall, showcases the Department of Biological Sciences' extensive collection of fossils, amphibians, fishes, birds, mammals, and insects that have been collected over the last 150 years. As part of the museum, the herbarium preserves the scientifically important collection of dried and pressed plants of the Greene-Nieuwland Herbarium. There are many opportunities for undergraduate research projects including identification and organization of specimens contained in museum collections, development of databases of plants and animals and their distributions, identification of rare, endangered, or invasive species, and development of thematic displays. Projects can be supported by the Robert E. Gordon Museum of Biodiversity Undergraduate Research Support Fund.

Contacts: Barbara Hellenthal (bhellent@nd.edu), Curator, and Ron Hellenthal (Ronald.A.Hellenthal.1@nd.edu), Director and Emeritus Professor.

Nanovic Institute for European Studies (nanovic.nd.edu)

The Nanovic Institute for European Studies is committed to enriching the intellectual culture of Notre Dame by creating an integrated, interdisciplinary home for students and faculty to explore the evolving ideas, cultures, beliefs, and institutions that shape Europe today. We help students from the College of Science plan and conduct focused, original scientific research in Europe. We support your high-quality European internships in laboratories and other scientific settings and make it possible for you to immerse yourself in local languages, to live among Europeans, and to see the world from a different perspective. Our students return to Notre Dame transformed with a new sense of confidence, awareness, and maturity that helps them to succeed. For more information on the Nanovic Institute and our undergraduate grant programs, please go to nanovic.nd.edu/grants-and-fellowships/undergraduate-students, or contact Jen Fulton.

Contacts: Jennifer Fulton (jfulton@nd.edu), Student Coordinator.

National Science Foundation Research Experience for Undergraduates (NSF-REU)

Notre Dame currently has two extant NSF-REU programs in the Depts. of Physics and Biology, which reflect similar programs available across the nation. For many years there was also very successful program in the Dept. of Mathematics. Programs usually consist of 10 weeks of full-time research, together with a intensive schedule of various enrichment activities, and typically provide stipend, housing, and travel allowance. Application materials for the Biological Sciences program can be found at http://nd.edu/~biosreu/, and for the Physics program at physics.nd.edu/research/reu/. Such REU programs at other institutions funded by NSF can be found at www.nsf.gov/crssprgm/reu/index.jsp.

Contacts: Dr. Umesh Garg (Umesh.Garg.1@nd.edu), Professor and Director, and Dr. Frank Connolly (connolly.1@nd.edu), Emeritus Professor.

The Ruth M. Hillebrand Center for Compassionate Care in Medicine

The central mission of the Ruth M. Hillebrand Center for Compassionate Care in Medicine (located in the Department of Preprofessional Studies) is to advance the scientific theory and practice of compassionate care in medicine and to promote effective communication skills in physicians, nurses, and allied health professionals. Along with instruction, continuing medical education, and networking, the Center also conducts research in the science of compassionate care in medicine. The Hillebrand Center is currently completing the Good Doc, Bad News research study in which the research team has been conducting a qualitative research study interviewing patients who feel their physician delivered bad medical news in the best way possible. Results will be used in future training of physicians in terms of best practices of breaking bad news and medical communication. Other projects include analyzing qualitative data on exemplary physicians on the art of medicine and quantitative data on the relation between empathy and burnout among physicians and other health care professionals. As these projects are completed, the Hillebrand Center will be embarking on new studies in the next year.

Contact: Dr. Dominic Vachon (Dominic.O.Vachon.1@nd.edu), Director.

Scientia (scientia.nd.edu)

Scientia, ND's own student-run Undergraduate Journal of Scientific Research, is looking for student reviewers and news writers for this year's publication. Reviewers should have some research experience and be interested in reading, critiquing, and commenting on student research. News writers can be from any discipline and must simply want to write about some of the cool things happening in the College of Science.

Contacts: Rachel Cotton (rcotton1@nd.edu), Rebecca Marton (rmarton@nd.edu), Co-Editors.

University of Notre Dame Environmental Research Center (UNDERC, nd.edu/~underc/)

UNDERC offers two 9½ week, 3 credit summer programs: East in the Upper Peninsula of Michigan and West in western Montana. Each has a set of modules (East: insect, forest, aquatic, and vertebrate ecology; West: environmental history tour, grassland/wildlife, montane, and Native American ecology), but the focus is an independent research project for each student

mentored by a faculty member or Ph.D. candidate. Admission to East is open to sophomores and above, and West requires attending East. Apply by early November on the UNDERC webpage and decisions are announced in early December to enroll in the preparatory course (1 credit, Spring semester).

Contact: Michael Cramer (mcramer@nd.edu), Assistant Director-East, Angela Laws (alaws@nd.edu), Assistant Director-West, and Gary Belovsky (belovsky.1@nd.edu), Director.

Webb-Waring Colorado Undergraduate Summer Program (WW-CUSP)

The Webb-Waring Center hosts an undergraduate research program to give undergraduate students an opportunity to experience firsthand the technical aspects of work in a research laboratory. This program has recently expanded because the center received an NIH Undergraduate Diversity Training Grant Award. This award supports two students from Princeton University and two students from the University of Notre Dame for several years. Webb-Waring students are offered a wide range of educational, advising and clinically related experiences to complement their research training. Summer students are taught by faculty from through-out the University of Colorado-School of Medicine. These experiences familiarize students with a number of future medical and research career paths.

www.ucdenver.edu/academics/colleges/medicalschool/centers/WebbWaring/Pages/Summer-Student-Program.aspx

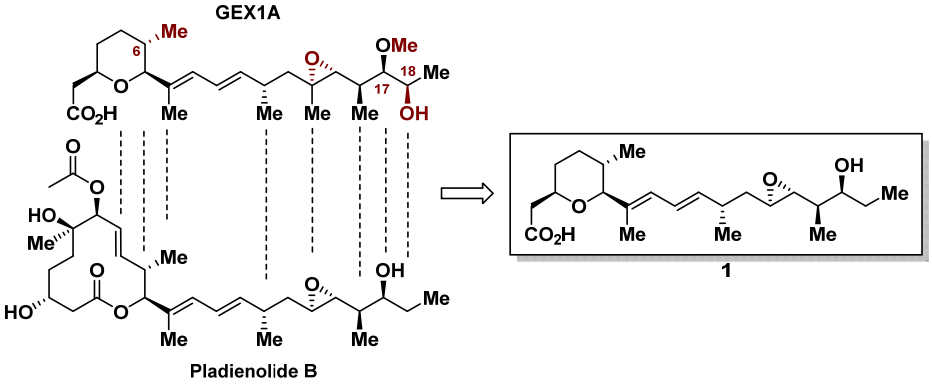
Contact: Dr. John Repine (John.Repine@ucdenver.edu), Webb-Waring Center Director.

Student Research Poster Presentations - Jordan Galleria

Synthesis Towards Novel GEX1A Analogues, a Potential Lead for Niemann-Pick Type C Disease

Michael Ahlers
Major: Chemistry
Advisor: Richard Taylor, Dept. of Chemistry and Biochemistry, University of Notre Dame
Coauthors: Jarred Pickering and Eve Granatosky

Niemann-Pick disease Type C (NPC) is a rare and fatal lysosomal storage disease that typically presents before the age of 10. Specifically, NPC is characterized by mutations to either the NPC1 or NPC2 proteins that result in defective cholesterol trafficking. Although hydroxypropyl β-cyclodextrin (HPβCD) and histone deacetylase inhibitors (HDACi) such as Trichostatin A are current therapeutic candidates for NPC, there remains no current FDA approved treatment. Our laboratory has recently demonstrated the ability of GEX1A, a type I polyketide natural product isolated from *Streptomyces chromofuscus*, to restore cholesterol trafficking in NPC1 mutant cell lines. Interestingly, herboxidiene is not an HDACi. In addition, we have observed the ability of GEX1A to restore cholesterol trafficking in HUVECs induced with the NPC phenotype. Thus, the synthesis of herboxidiene analogues to be tested in NPC1 and NPC2 mutant cell lines is necessary in order to determine the minimal functionality required for activity against NPC as well as the mechanism of action of GEX1A. Intriguingly, novel anti-cancer natural product pladienolide B shares both structural and biosynthetic similarities with GEX1A. Accordingly, we are currently engaged in the synthesis of an analogue that incorporates the linear side chain of pladienolide B while retaining the western hemisphere of GEX1A. An organic synthesis towards rationally designed analogue **1** of GEX1A is outlined.



What inspired you to participate in undergraduate research?
I was intrigued by organic chemistry and its vast applications to other areas of science, specifically drug development, from the very beginning. I wanted to understand organic chemistry not only from a theoretical, lecture-based standpoint, but also in how it is applied every day in the laboratory.

How did you get your research position, and what preparation did you undertake for it?
I have been a member of the Taylor Group since the fall of 2012. I was prepared for the position from organic chemistry lecture and lab taught here at the University of Notre Dame.

Where was your research experience located?
Stepan Chemistry, University of Notre Dame.

What did you get out of your research experience?

My research in the Taylor lab has taught me how to approach a large research project and solve both small problems such as getting a reaction to work and also larger problems such as trying to help cure NPC. My research has taught me many synthetic chemist techniques such as reaction design, isolation, purification, and characterization. Throughout this process, I have gained friends and collaborators that have truly enlightened by Notre Dame experience. I was fortunate enough to be funded this past summer by the Notre Dame College of Science Summer Undergraduate Research Fellowship.

***The effects of a parasitic mite*—Ectrombidum locustorum—*on the competitive interactions between two pest grasshopper species*—Melanoplus sanguinipes *and* Ageneotettix deorum**

Nick Anderson
Major: Biology
Advisor: Gary Belovsky, Dept. of Biological Sciences, University of Notre Dame

To date, many studies have examined the effects of a natural enemy, such as a predator or a parasite, or competitor on an organism. Far fewer studies have examined how a natural enemy effects the interaction between competitors. Presently there is an increasing interest in integrating these traditionally separate fields with the goal of better understanding the true interactions between organisms. One of the possible applications for increased understanding of natural interactions is in the development of effective Integrated Pest Management (IPM). In keeping with these themes, this study explored the effects of an ectoparasitic mite, *Eutrombidium locustorum* (Walsh), on the interspecific competition between two pest grasshopper species—*Ageneotettix deorum* (Scudder) and *Melanoplus sanguinipes* (Fabricius). We hypothesized that parasitism by *E. locustorum* would increase *M. sanguinipes'* feeding activity and thereby increase its competitive impact on *A. deorum*. Field experiments were conducted to determine the effects of these combined interactions on the grasshopper species, while lab feeding trials were done to examine changes in feeding behavior caused by parasitism. The results of these experiments suggest that *E. locustorum* increases the competitive ability of host *M. sanguinipes* by increasing its feeding activity and competitive ability both in late instar and adult grasshoppers. While many studies have shown the potential of *E. locustorum* as a biocontrol agent, the results of this study suggest that use of this mite should be more carefully considered, as the use of this mite to control one pest species may be countered by an increase in the destructive capabilities of another species. This suggests that further research is needed to better document *E. locustorum*'s potential as a biocontrol agent.

What inspired you to participate in undergraduate research?
I have been involved with research at Notre Dame since the summer following my freshmen year and I have truly enjoyed it. This research experience was an extension of that, and allowed me to further enhance my abilities to answer some of the interesting ecological questions that I have.

How did you get your research position, and what preparation did you need?
I attended UNDERC-East (the prerequisite course for participating in UNDERC-West) during the summer of 2012. Following the summer, I began working in Dr. Gary Belovsky's (the director of the UNDERC programs) lab on campus doing independent undergraduate research. I applied for UNDERC-West because my research experience to that point had been in aquatic systems and I wanted to explore terrestrial systems. In order to prepare for time at UNDERC-West, I took a one-credit introductory course required to participate in the program.

Where was your research experience located?
University of Notre Dame Environmental Research Center-West (in Northwestern Montana)

What did you get out of your research experience?
This experience added to my overall research experience by allowing me to explore a problem that I was interested in as well as giving me the opportunity to collaborate with fellow undergraduates on their—sometimes vastly—different projects. I think that the opportunity to observe and help other undergraduates with their own research is one of the great strengths of the UNDERC program.

Predicting the Invisible Z Background in All-Hadronic Supersymmetry Searches Using SHERPA

Christopher Barnes
Major: Physics
Advisors: Jay Dittmann and Kenichi Hatakeyama, Dept. of Physics, Baylor University, Waco, TX

The cross section for the production of Z + 3 jets in high-energy proton-proton collisions cannot be easily measured if the Z particle decays into two neutrinos, because neutrinos currently cannot be detected experimentally. However, the Z + 3 jets cross section can be estimated by the cross section of a photon + 3 jet interaction if the two maintain a constant ratio with one another as a function of several kinematic variables. The project uses a Monte Carlo event generator called SHERPA (Simulation of High Energy Reactions of Particles) to explore whether the ratio is indeed constant over a range of kinematic quantities. Three quantities of interest within this project are H_T, the scalar sum of jet transverse momentum, MHT, the missing transverse momentum within a particle interaction, and delta phi, the angle between the MHT vector and the least-energetic jet. The data within each histogram were subject to specific requirements, or cuts, that limited the events under study to those that exceeded certain threshold values of H_T and MHT, but these cuts did not have a significant effect on the behavior of the histograms. The results found that the ratio between the two cross sections remains fairly constant for all set cuts of the histograms of H_T, while the various cuts of H_T and delta phi show positive slopes for low values of these quantities. All of these data agree well with the work of theorists within other publications, and these studies offer insight into the invisible Z background in all-hadronic supersymmetry searches at the Large Hadron Collider.

What inspired you to participate in undergraduate research?
I was eager to apply the principles of mechanics and special relativity taught in Physics A and B to groundbreaking work performed within a professional research environment, and a project in high-energy physics naturally employs these and other concepts. I had started work with the Notre Dame High Energy Physics Group my sophomore year and enjoyed it, so I continued on in the same field as a participant in the Baylor University Research Experience for Undergraduates (REU) program.

How did you get your research position, and what preparation did you undertake for it?
I applied to a number of REUs at universities around the country from the listing on the National Science Foundation website, and Baylor University accepted me into their program and offered me work in high-energy physics, my chosen field. My knowledge of C++ and Unix collected at Notre Dame eased my transition into the work of my project.

Where was your research experience located?
Baylor University

What did you get out of your research experience?
In addition to increasing my understanding of C++ and Unix, I learned the fundamentals of LaTeX, the language used to publish scientific papers. The REU program offered valuable exposure to the life of a graduate student performing academic research, which is much different than performing a small amount of research while simultaneously taking classes. Living in Texas for the summer capped off the experience, because I was able to travel around the state on weekends and over the Fourth of July when my family visited. Additionally, the REU program funded my visit to Fermilab in Batavia, Illinois for three days over the summer, which provided me with insight into a daily work routine at the mecca of U.S. high-energy physics.

Characterization of Layer-by-Layer DNA/PLA Microcapsules by Atomic Force Microscopy

John Brems
Major: Physics in Medicine
Advisor: Sylwia Ptasinska, Dept. of Physics, Notre Dame Radiation Laboratory,
University of Notre Dame

Applications of DNA beyond its role as the carrier of genetic information are being increasingly studied in the field of nanotechnology. Because of its uniform negative charge, DNA can electrostatically self-assemble to form bilayers with polycations. One especially intriguing function of these bilayers is as microcapsules to carry drugs for targeted physiological release in response to a variety of chemical factors. However, because this is still an emerging field, a further understanding of the formation and properties of the multi-layered microcapsules is still needed. In this study, microcapsules were formed using DNA and poly-L-arginine (PLA) as the polyanion and polycation, respectively. The microcapsules were deposited onto mica substrates and imaged using Atomic Force Microscopy (AFM). AFM images were used to qualitatively analyze the formation of microcapsules. Capsules made of 1, 2, and 3 bilayers were fabricated and imaged. The findings suggest that the formation and stability of these may be relatively similar with a low number of bilayers. Preliminary studies are ongoing to examine the role of other experimental factors in the formation of these microcapsules.

What inspired you to participate in undergraduate research?
I wanted to see practical applications of science, which I had only learned in the classroom. I thought working on a research project would teach me a lot about critical thinking.

How did you get your research position, and what preparation did you undertake for it?
I talked to an adviser in the Physics department who referred me to Dr. Ptasinska in Febraury of 2012. Although I had learned some skills in lab courses, I learned most things by working with a graduate student for a few months in Dr. Ptasinska's lab.

Where was your research experience located?
The Radiation Laboratory at the University of Notre Dame

What did you get out of your research experience?
My experience enabled me to spend a great summer at Notre Dame. I loved learning from and getting to know the other members of my lab. Undertaking research taught me a lot about problem solving, working in a team, and understanding scientific questioning. Although I am going into medicine, these skills from research translate fantastically.

The Role of Chemokines in Trunk Neural Crest Cell Migration

Elena Brindley
Major: Biological Sciences and Psychology
Advisors: Jennifer Kasemeier-Kulesa and Paul Kulesa,
Stowers Institute for Medical Research, Kansas City, MO

The neural crest (NC) cells are a multipotent and highly migratory embryonic population of cells that emigrate from the dorsal neural tube during vertebrate development. These cells travel long distances through the embryo, and, in the trunk, contribute to form the sensory and sympathetic nervous systems and melanocytes of the skin. However, it is unclear what molecular signals guide the subpopulations of trunk NC cells to their precise target sites. Chemokines are a family of small secreted proteins capable of long-distance signaling. Previous studies from our lab have identified a role for the chemokine ligand Sdf-1 and receptor CXCR4 to guide only early emigrating trunk NC cells to the primary sympathetic ganglia (SG). Here, we focus on identifying whether other chemokines are involved during the different phases of trunk NC cell migration that may contribute to either the SG, the dorsal root ganglia (DRG), or melanocytes. To address this, we use immunohistochemistry (IHC) and 3D confocal microscopy to map the spatio-temporal protein expression patterns of the chemokine ligands CCL21, CCL25 (TECK), and IL8, and their respective receptors CCR7, CCR9, and CXCR1, during different phases of trunk NC cell migration. Preliminary immunohistochemistry results suggest putative migration guidance roles for CCL21and CCL25. To test the ability of these receptor-ligand pairs identified by IHC to direct trunk NC cells we use chemotaxis and stripe assays, together with in vivo bead implants. In summary, these results will help us better understand which chemokines may be involved in trunk NC migration and provide a framework for further gain and loss of function studies.

What inspired you to participate in undergraduate research?
I love the idea of finding a fascinating question in science and dedicating yourself to answering that question. I also wanted to experience what I was learning in the classroom in real life and gain laboratory skills.

How did you get your research position, and what preparation did you undertake for it?
I worked in the Kulesa Lab through the Summer Scholars Program at the Stowers Institute for Medical Research. I found information about this program online and I was immediately drawn to the unique mission of the institute, “Hope for Life”. To prepare, I read the suggested and most recent publications from the lab, and kept in contact with my lab via email before I arrived.

Where was your research experience located?
Stowers Institute for Medical Research, Kansas City, MO 64110

What did you get out of your research experience?
This was by far the best summer I’ve ever experienced. I had access to world class science, facilities, and mentors all summer long, and I met so many amazing people. It was great to bond with fellow science students, and I really learned a great deal just from talking with people in the scientific community every day.

Effects of parasitic infection of invasive rusty crayfish on their impacts on macrophyte populations in lakes

Margaret Corcoran
Major: Environmental Science
Advisors: Lindsey Sargent and David Lodge, Dept. of Biological Sciences, University of Notre Dame

Rusty crayfish (*Orconectes rusticus*) are an invasive species in northern Wisconsin, where they out-compete native crayfish and deplete aquatic macrophyte populations in lakes where they are present. Rusty crayfish have had major impacts on lake communities, reducing biodiversity on multiple trophic levels. Crayfish infection by a trematode parasite (*Microphallus spp.*) alters crayfish behavior, but the effects of this parasite on the lake-wide impacts of rusty crayfish are currently unknown. In this experiment, the effects of parasitic infection and presence of predatory fish on rusty crayfish impacts on aquatic macrophytes was tested in large mesocosms designed to replicate the lake ecosystem. We predicted that parasitic infection would increase crayfish impacts on macrophytes because previous research indicates that infected crayfish are bolder in the presence of fish predators. Data analysis is currently underway and results will be presented in the poster.

What inspired you to participate in undergraduate research?
I love ecological field work, so when the opportunity to do research in Northern Wisconsin was presented to me by my graduate student advisor Lindsey Sargent, I was excited to participate in her project and do this research.

How did you get your research position, and what preparation did you undertake for it?
I had been working in David Lodge's lab (which focuses on aquatic invasive species) throughout the year, and Lindsey needed an undergraduate student to assist her with her project. This presentation focuses on one important aspect of the project: aquatic plants. I was funded with a Notre Dame College of Science Summer Undergraduate Research Fellowship.

Where was your research experience located?
University of Wisconsin Trout Lake Station

What did you get out of your research experience?
I had a great time at University of Wisconsin's Trout Lake Station, where I made friends and met a number of graduate students and professors doing interesting research projects, which I came to learn about as well. UWTLS is also located very closely to University of Notre Dame Environmental Research Center, where I spent some time doing fieldwork. Overall, I feel my greatest experience was participating in fieldwork in aquatic ecology, which has inspired me to pursue a career in ecological research!

The Incidence Rate of Several Tick-Borne Diseases in Potential Hosts in the midwestern United States

Ian Cronin
Major: Science-business
Advisor: Benjamin Ridenhour, Dept. of Biological Sciences, University of Notre Dame

Several tick-borne diseases including Ehrlichiosis, Rocky Mountain Spotted Fever, and Babesiosis have become more prevalent in the United States and are a growing public health concern. However, just how widespread these diseases are in the midwestern United States is still unclear. In order to address this, dog tick (Dermacentor variablis) samples were collected from the University of Notre Dame Environmental Research Center (UNDERC) in Wisconsin. Tissue samples from mice (Peromyscous leucopus and Peromyscous maniculatus), shrews (Sorex cinerus and Blarina brevicauda) were collected from UNDERC; Peromyscus blood samples were also collected. Each of these samples were tested for Ehrlichia spp, Rickettsia spp., and Babesia spp using a polymerase chain reaction based diagnostic test. There was evidence of each disease in the 76 Dermacentor ticks collected. Babesia spp. was present in all three of the mice sample sets collected and both of the shrew sample sets. Rickettsia spp. was present in both shrew sample sets, but none of the mice. And Ehrlichia spp. was present in the Peromyscous Maniculatus and the Peromyscous blood samples, but none of the other samples. The presence of all of these diseases in Dermacentor Variablis ticks suggests that there is more than one vector possible for the bacteria.

What inspired you to participate in undergraduate research?
I always wanted to get involved in the scientific process. I had been learning everything in class for a while but I wanted to be part of how what I had been learning becomes common scientific knowledge.

How did you get your research position, and what preparation did you undertake for it?
I read about Professor Ridenhour's research on his website and sent him an email saying that I would be interested in working in his lab.

Where was your research experience located?
University of Notre Dame

What did you get out of your research experience?
I had always been a little intimidated by research prior to getting involved in it. Now I have come to realize that it is actually really cool and exciting. I have become proficient at reading and analyzing scientific papers, and writing them. I have also become comfortable working in a laboratory that is something I am going to pursue in my gap year before medical school.

Evaluation of **Acilius** *Larvae (Coleoptera: Dytiscidae) for Biocontrol of Mosquito Larvae*

Nicholas Deason
Major: Biology
Advisor: Todd Crowl, iUTAH Project Director and Principal Investigator,
Utah National Science Foundation EPSCoR

Mosquitoes are common nuisance pests as well as the primary vectors for several human diseases. Current methods of mosquito control rely mostly upon expensive and highly regulated sprayings of insecticides. As a result, methods for biological control have received increased scientific attention in recent years. This report evaluates the mosquito control potential of aquatic larvae of Acilius dytiscid beetles collected in northern Wisconsin and Michigan. Results showed that Acilius were effective predators of mosquito larvae, increasing their predation rates in the presence of high densities of mosquito prey. Dytiscids were able to completely eliminate mosquito larvae from outdoor aquatic mesocosms over several days. Additionally, Acilius larvae preferred to prey on mosquito larvae over chironomid larvae when given a choice in laboratory experiments. These findings suggest that Acilius larvae have potential for biocontrol of larval mosquito populations, but further study is needed to determine the methodology for augmentative release and other potential effects of widespread application.

What inspired you to participate in undergraduate research?
I took the Cell Bio Research Lab course and have been hooked ever since.

How did you get your research position, and what preparation did you undertake for it?
I conducted this research through the UNDERC summer program which I applied for at underc.nd.edu.

Where was your research experience located?
University of Notre Dame Environmental Research Center in northern Wisconsin and Michigan.

What did you get out of your research experience?
An opportunity to design and conduct my own research, great friends and faculty mentors, and summer of fishing, hiking and science.

Zhu's Algebra Constructions for Vertex Operator Algebras: An Introduction to the Algebra of String Theory

Mitchell Faulk
Major: Mathematics
Advisor: Katrina Barron, Dept. of Mathematics, University of Notre Dame
Coauthors: Nathan Vander Werf

Conformal field theory (string theory) is an attempt at a physical model encompassing all known forces, including gravity. My research attempts to understand the complicated algebraic structures at play in this physical model. In particular, the geometric (world-sheet) interactions of closed strings propagating through space-time can be understood through algebraic objects known as vertex operator algebras. These objects have a structure that is governed on the geometric side by the "sewing equation," which states how strings should interact in space time. These vertex operator algebras, however, are extremely complicated, consisting of infinite-dimensional vector spaces together with infinite families of algebraic relations. Using the information of a given vertex operator algebra, one can construct a much simpler (sometimes finite-dimensional) algebra (known as Zhu's algebra) which keeps "enough" of the information of the original vertex operator algebra. My research involves studying this type of algebraic correspondence in more general settings.

What inspired you to participate in undergraduate research?
I enjoy tackling difficult, abstract questions, and I wanted to gain enough knowledge to contribute to research in the interesting area of mathematical physics, my intended field of study in graduate school.

How did you get your research position, and what preparation did you undertake for it?
I have been studying the theory of vertex operator algebras under the direction of Dr. Barron since my sophomore year. During the years before last summer, I spent a lot of time reading textbooks and discussing the material with Dr. Barron and her graduate student, Nathan Vander Werf. Excited to get involved with research, I submitted a proposal to be funded by Notre Dame's 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?
I matured as a mathematician, learning the ins and outs of math research. Not only did I gain considerable knowledge in a specific field, but I also broadened my math knowledge by integrating various other topics into my studies. This research experience afforded me a solid foundation to conduct further research not only within my intended field, but within other fields of mathematics as well.

The Role of APC in Chemotherapeutic Responsiveness of Breast Cancer

Katia Fernandez Soto
Major: Science Pre-Professional
Advisor: Jenifer Prosperi, Dept. of Biological Science, University of Notre Dame, Indiana University School of Medicine – South Bend, and Harper Cancer Research Institute

While chemotherapy is often capable of inducing cell death in tumors and reducing tumor bulk, many cancer patients experience recurrence and ultimately death because of treatment failure. The ability of cancer cells to become resistant to different drugs is called multi-drug resistance. Therapeutic resistance develops by numerous mechanisms, which include increased drug efflux through ABC-transporters, and evasion of drug-induced apoptosis by tumor-initiating cells. Our laboratory studies the Adenomatous Polyposis Coli (APC) tumor suppressor, which is known to interact with microtubules and DNA repair pathway components. The hypothesis for my studies is that APC mutation in mouse and human mammary tumor models mediates therapeutic responsiveness. The expression of the ABC-transporters, ABCG2 and MDR1, in cell lines isolated from tumors in MMTV-PyMT;$Apc^{Min/+}$ or MMTV-PyMT;$Apc^{+/+}$ mice was analyzed using Real-Time PCR. The expression and enzymatic activity of ALDH1 was used to assess the tumor-initiating cell population via western blot and ALDEFLUOR assay, respectively. To analyze the proliferative effects of 4 commonly used chemotherapeutic agents (paclitaxel, 5-fluorouracil, cisplatin, and doxorubicin), an MTS-based assay was used. Our results suggest that cells isolated from an MMTV-PyMT;$Apc^{Min/+}$ tumor demonstrated elevation of both MDR1 and ABCG2 and a lower expression of ALDH1. Two chemotherapeutic agents (paclitaxel and 5-fluorouracil) showed alterations in efficacy in the two cell lines tested. To translate our findings to a human breast cancer cell line, we utilized the human breast cancer cells, DU4475, which harbor a mutation in the β-catenin binding region of APC. We have engineered these cells to express multiple fragments of APC, and have specifically focused on the middle region and C-terminal domain of APC. Similarly, introduction of the C-terminal or middle domain of APC into DU4475 human breast cancer cells resulted in increased sensitivity to all four drugs tested. Future studies will involve the continued validation of results in the DU4475 cohort of cells and the investigation of specific binding domains of APC regulating therapeutic responsiveness in breast cancer.

What inspired you to participate in undergraduate research?
I took the initiative to take a course my freshman year called "Introduction to Research" because I wanted to get involved in research on campus. I had always thought that the field of research was challenging and I was ready for that challenge after my freshman year of college.

How did you get your research position, and what preparation did you undertake for it?
I interviewed with Dr. Prosperi in August 2012, and have been a member of the Prosperi Lab since September of 2012. I spent the first few months reading literature on the topic of cancer and then focused gradually on breast cancer and the tumor suppressor APC. During the spring of 2013, I submitted a research proposal to stay on campus during the summer and work full-time at the Harper Cancer Research Institute. The Notre Dame College of Science Summer Undergraduate Research Fellowship (COS-SURF) provided funding for my research during the summer.

Where was your research experience located?
Harper Cancer Research Institute – University of Notre Dame and Indiana University School of Medicine – South Bend.

What did you get out of your research experience?

My research experience during the summer was very different from my research experience during the academic year. I learned that working ten hours a week is not enough time to accomplish what I want, and I learned that I wanted to spend more time doing research. This experience inspired me to consider applying to M.D./Ph.D. programs and integrate cancer research in my long-term career goals. Also, working forty hours a week gave me the opportunity to get to know the people in my lab more and learn about their projects and how my project integrates into the research goals of the lab.

Generation of* Nocardiopsis fulvus *mutants capable of producing 20-deoxyapoptolidin

Drew Gasparrini
Major: Biochemistry
Advisor: Richard Taylor, Dept. of Chemistry and Biochemistry, University of Notre Dame
Coauthors: D. Cole Stevens, Danielle Ronnow

Apoptolidin is a polyketide produced by *Nocardiopsis fulvus* that is a promising chemotherapeutic agent due to its ability to selectively induce apoptosis via inhibition of the F_0F_1-ATPase. However, native apoptolidin is susceptible to a ring expansion-isomerization through an acyl migration of the C-20 hydroxyl group to form a significantly less bioactive analogue, isoapoptolidin. This isomerization can only occur if the C-20 hydroxyl group necessary for acyl migration is present. To this end, we sought to produce the apoptolidin analogue 20-deoxyapoptolidin by inactivating *apoD$_1$-D$_3$*, the genes encoding the Reiske oxygenase responsible for installation of the hydroxyl moiety at the C-20 position. To date, the *N. fulvus apoD$_1$-D$_3$::*Apr^R mutant has successfully been generated, and efforts to isolate and characterize 20-deoxyapoptolidin are ongoing.

What inspired you to participate in undergraduate research?
I wanted to get involved in undergraduate research in order to apply what I was learning in my classes in a research lab.

How did you get your research position, and what preparation did you undertake for it?
I read through the research descriptions of the faculty on the Department website and found the Taylor Group's research particularly interesting so I contacted Professor Taylor. Fortunately the group had an undergraduate position available, and I started working as soon as I could. In addition to my research during the school year, I was able to work full time in the lab this past summer through the College of Science Summer Undergraduate Research Fellowship.

Where was your research experience located?
The Department of Chemistry and Biochemistry at the University of Notre Dame.

What did you get out of your research experience?
My research experience has taught me what it is like to do research in an academic setting. I have really enjoyed working in the Taylor Group as it has given me the opportunity to participate in exciting research, work with closely with graduate students and postdocs, and learn a number of advanced molecular biology techniques.

NMR ^{13}C-^{1}H and ^{13}C-^{13}C Spin-couplings in Aldofuranosyl Rings: DFT Studies of Structural Correlations as a Foundation for Quantitative Analyses of *J*-Coupling Ensembles by *MA'AT*

Matthew Hadad
Major: Biological Sciences
Advisor: Anthony Serianni, Dept. of Chemistry and Biochemistry, University of Notre Dame

Conformational flexibility is a hallmark of the aldofuranose rings of nucleic acids, such as RNA and DNA, and other biologically relevant oligo- and polysaccharides. The conventional north/south (*N*/*S*; C3'-*endo*/C2'-*endo*) equilibrium commonly invoked to explain the behaviors of these rings is based largely on experimental observations made on model systems in the solid state (x-ray crystallography). Solution studies by NMR are largely confined to the observation of ^{1}H-^{1}H spin-couplings (*J*-couplings) and nuclear Overhauser effects (NOEs), and to a lesser degree, residual dipolar couplings (RDCs), which are used collectively to determine which regions of the pseudorotational itinerary are preferred and to establish conformational equilibria. For example, rings having the b-D-ribofuranose configuration **1** contain three $^{3}J_{HH}$ values ($^{3}J_{H1,H2}$, $^{3}J_{H2,H3}$, $^{3}J_{H3,H4}$) to describe an itinerary comprised of 20 conformers (*P* values), and considerably more conformers are potentially accessible if puckering amplitudes (*t* values) are added to the mix. Clearly this system is severely under-determined. To address this limitation, we are investigating, by DFT,[1] NMR *J*-couplings in these rings involving carbon, specifically J_{CH} and J_{CC} values over 1–3 bonds that show strong sensitivities to ring conformation.[2] As shown recently for conformational analyses of *O*-glycosidic linkages in oligosaccharides using the computer program *MA'AT*, we aim to interpret this ensemble of *J*-values quantitatively in order to place conformational assignments of aldofuranose rings in solution on firmer experimental ground and validate structural predictions made from MD simulations of these systems.

What inspired you to participate in undergraduate research?
I have always been fascinated by the horizon of scientific knowledge. Research has given me the chance to be the first to discover new phenomenon within science.

How did you get your research position, and what preparation did you undertake for it?
I got my research position through a relative who collaborates with Professor Serianni in another research institution. I began this position in the Spring of 2012. All my preparation took place on the job, and most took place in a trial-and-error approach.

Where was your research experience located?
University of Notre Dame

What did you get out of your research experience?
This experience has provided me with a better understanding of the research process (including documentation, grants, and proper lab decorum. A resiliency to pursue in the face of complexity and discouragement is essential for success in research, and I developed this resiliency in this project.

Changes in circulating and tissue-specific miRNA expression in T1D pathogenesis

Jeff Hansen
Major: Biology
Advisor: Kenneth Brayman, Dept. of Surgery, University of Virginia, Charlottesville, VA

Type 1 diabetes (T1D) is an autoimmune disease that ultimately results in the complete destruction of insulin-secreting pancreatic beta-cells. Ongoing research has shown that microRNAs (miRNAs) play a role in T1D pathology, both through correlative and causative experimentation. The advent of miRNA research has provided novel methods for predicting disease onset, monitoring progression and effects of treatment, and identifying targets for therapeutic intervention. Characteristics of microRNAs – high stability in extracellular fluid, high cellular abundance, and conservation across species - allow miRNAs to be quantified and used as biomarkers for disease. By examining miRNA expression at progressive time points in T1D development in NOD and NOD-SCID mice, differentially expressed miRNAs can be identified. Unique miRNAs then have twofold advantage: providing a predictive marker for disease onset and elucidating mechanistic value for miRNAs in pathogenesis. Predictive markers allow for the administration of preventative treatment prior to beta-cell death, preventing or delaying the onset of T1D. Understanding mechanistic value through miRNA manipulation experiments may allow for the design of therapeutic treatments to alter disease pathways.

What inspired you to participate in undergraduate research?
I have been motivated to cure type 1 diabetes since I was twelve years old and understood the suffering that three of my family members go through on a daily basis. In order to reach my goal, I have tried to immerse myself in as many research and scientific experiences as possible.

How did you get your research position, and what preparation did you undertake for it?
This was the second summer working in Dr. Brayman's lab. Two years ago I read about Dr. Brayman in the Washington Post, specifically that he conducts research on type 1 diabetes at the University of Virginia, which is located two hours south of my house. I contacted Dr. Brayman and asked if I could research in his lab and he welcomed me with open arms. For preparation, I did background research on biomarkers and prepared a research proposal and plan so that I could hit the ground running.

Where was your research experience located?
University of Virginia, Charlottesville, VA

What did you get out of your research experience?
My benefits were two fold: expanding my knowledge on type 1 diabetes and learning how to work in a research lab environment. I was able to survey the literature on biomarkers for T1D, learn common protocols, and conduct my own project on identifying biomarkers. I was also able to learn how to communicate with collaborating labs, design and conduct my own project, and then prepare and present my results.

The miR-23a miRNA Cluster Forms a Gene Regulatory Loop with B cell Transcription Factors in Hematopoietic Cells

Justin Hansen
Major: Biological Sciences
Advisor: Richard Dahl, Dept. of Biological Sciences, University of Notre Dame and Indiana University School of Medicine South Bend
Coauthors: Audrey Rich, Cancer Research and Treatment Center, University of New Mexico Health Sciences; John Ning and Anthony Sanchez, Harper Cancer Research Institute and Dept. of Biological Sciences, University of Notre Dame; Emmanuel Bikorimana, Dept. of Biological Sciences, University of Notre Dame and Indiana University School of Medicine South Bend, and Richard Dahl, Harper Cancer Research Institute, Dept. of Biological Sciences, University of Notre Dame, and Indiana University School of Medicine South Bend

The miR-23a cluster inhibits B cell development in vitro and in vivo when it is exogenously expressed in mouse hematopoietic progenitors. Microarray analysis of pre-B cells expressing miR-23a cluster miRNA miR-24 demonstrated that miR-24 enhanced the expression of genes associated with myeloid hematopoietic cells (monocytes and granulocytes) and decreased the expression of B cell associated genes. Interestingly three transcription factors essential for B cell development, E2A, EBF1, and Pax5 were all decreased when miR-24 was overexpressed in pre-B cells. Along with activating essential B cell genes it has been shown that these factors also repress the genes associated with the myeloid lineages. Analysis of conserved non-coding DNA regions upstream of the mrn23a gene demonstrated the presence of putative binding sites for these three transcription factors. Transient transfection reporter analysis with putative regulatory regions from the mrn23a locus indicated that each of the three transcription factors could negatively regulate mrn23a transcription. Chromatin immunoprecipitations were performed and demonstrate that EBF1 associates with the mrn23a locus in B cell lines. Our data suggests that a regulatory loop exists between these miR-23 cluster miRNAs and B cell transcription factors. The miR-23a miRNAs repress the expression of B cell transcription factors to promote myeloid cell development, whereas E2A, EBF1, and Pax5 inhibit myeloid genes including mrn23a to promote B cell development. Notes: Early B-cell factor (EBF) contains two functional domains an N-terminal cysteine-rich region essential for DNA binding, and a C-terminal dimerization region containing two 15-amino acid repeats with similarity to the dimerization domains of basic helix-loop-helix (bHLH).

What inspired you to participate in undergraduate research?
My love of learning and desire to discover new things influenced me to participate in undergraduate research.

How did you get your research position, and what preparation did you undertake for it?
I first met my advisor Richard Dahl at the Biology Club Networking dinner in the Fall of 2011. His lab's focus on gene regulation in hematopoietic development sounded fascinating, so emailed him and started researching in his lab the following Spring.

Where was your research experience located?
University of Notre Dame, Harper Cancer Research Institute

What did you get out of your research experience?
So far, I have gained so much knowledge about the field of Immunology and how miRNAs are vital components of gene regulation for differentiation of immune cells. I also have learned many research techniques that will give me a solid base for future positions in research labs.

Diel Horizontal Migration of Zooplankton Across a Gradient of Dissolved Organic Carbon

Julia Hart
Major: Environmental Sciences
Advisor: Patrick Kelly, Dept. of Biological Sciences, University of Notre Dame

Increased browning of global freshwater ecosystems, a result of increased dissolved organic carbon (DOC), can significantly alter both the biotic and abiotic characteristics of aquatic systems. Most prominent among abiotic changes is a darkening, or browning, of the water color. Previous research has shown that diel migration patterns of freshwater zooplankton, an integral part of freshwater food webs and trophic interactions, stand to be affected by changes in water color. While much is known about the diel vertical migration (DVM) patterns of zooplankton, little research has been done on diel horizontal migration (DHM) in freshwater systems. This study asks how increased DOC affects diel horizontal migration in north temperate lakes. As water color increased across three lakes, diel horizontal migration generally decreased. In Bay Lake, the lightest lake, zooplankton abundance was significantly greater in the open water sites than the littoral zone during the day (transect 2, $p=0.0337$). There was no significant difference in zooplankton abundance across the surface of Hummingbird Lake, the darkest lake, during the day or at night. With darker water color, zooplankton are provided refuge from visual predators, allowing them to remain in the food- and oxygen-rich epilimnion, distributed across the entire surface of the lake, at any time of day. Overall, by focusing on DHM, a pattern largely neglected by most zooplankton migration studies, this study may provide implications for future food web studies.

What inspired you to participate in undergraduate research?
I wanted to become involved in undergraduate research after taking a course in aquatic ecology. I loved the material and wanted to explore how the concepts learned in class were studied in the field.

How did you get your research position, and what preparation did you undertake for it?
This research was conducted as part of the Practicum in Environmental Field Biology at the University of Notre Dame Environmental Research Center (UNDERC) in the Upper Peninsula. I applied for the program to gain experience in fieldwork and in conducting my own research project.

Where was your research experience located?
University of Notre Dame Environmental Research Center (UNDERC)

What did you get out of your research experience?
I gained invaluable experience when it comes to collecting my own data, drafting proposals, and generating a scientific paper and presentation. The UNDERC program as a whole exposed me to many different types of biological field research and taught me to think like an ecologist. This research experience provided an excellent base for any future graduate studies.

Testing Patient Compliance with Medication Regimens

Eliza Herrero,
Major: Chemistry and Sociology
Advisor: Marya Lieberman, Dept. of Chemistry and Biochemistry, University of Notre Dame

Four in ten children taking Tuberculosis medications do not take their pills as instructed by medical professionals, found one study. Not only does non-compliance to medication cause treatment failures, but it also contributes to the rise of drug resistant strains of pathogens and puts an economic strain on the healthcare industry. The aim of this research was to develop a methodology for field-testing in resource poor/developing countries that will provide accurate feedback on patient adherence to a particular drug regimen. A study was conducted with 10 participants who were asked to follow a certain regimen of taking Vitamin B3. Compliance was monitored via testing for the presence of vitamin B3 in urine. The method developed for field-testing was a Paper-based Analytical Device (PAD), which is based on a simple colorimetric reaction. The validity of this test was confirmed with a "Gold Standard" method of analysis: quantitative HPLC analysis. Comparison of these two tests will show the limit of detection of the PAD as well as the ability of laypeople to run the field test themselves. The impact of a gentle "nudge" on compliance with the regimen was also examined; results suggested daily reminders have a positive effect on improving compliance. The results from this brief study will extended to testing for compliance to Isoniazid, a Tuberculosis medication structurally similar to Vitamin B3.

What inspired you to participate in undergraduate research?
Working in a lab let me see a side of Chemistry I was not exposed to in classes. I love being able to take an active role in fighting problems in health care, with a direct impact.

How did you get your research position, and what preparation did you undertake for it?
I started work in the Lieberman lab January 2013 so had been working in the lab for a full semester. My work this summer was an extension of the work I had been conducting during the year, taken in a Sociological context, specifically theories of patient compliance. My work was funded by ISLA, through a Summer Comprehensive Grant.

Where was your research experience located?
University of Notre Dame

What did you get out of your research experience?
The chance to truly devote myself to my research interests and take the project in a direction that most interested me. I also learned invaluable lab skills in a variety of methods that will help me in future graduate work. And of course, the chance to see Notre Dame in the summer months, rather than winter!

Exploring the role of fgf signaling in the regenerating zebrafish mesonephros

Jonathan Jou
Major: Biological Sciences
Advisor: Rebecca Wingert, Dept. of Biological Sciences, University of Notre Dame

Nephrons, the functional unit of the kidney, are segmented epithelial tubules that clear the blood of toxins, absorb ions, and maintain water homeostasis. Damage to nephrons leads to renal dysfunction, a condition associated with both acute and chronic kidney diseases. The high degree of conservation between zebrafish and human nephrons and the innate ability of zebrafish to regenerate nephrons provides a relevant model for investigating the mechanisms of epithelial regeneration and exploring the signaling pathways that control neonephrogenesis. In this project, we are assessing the role of fibroblast growth factor (fgf) signaling. The Fgf family of growth factors are closely associated with kidney nephron growth and branching in murine models. Thus, we hypothesized that Fgf signaling may play one or more roles in regulating nephron regeneration and specifically chose the genes fgf2, fgf7, fgf8a and fgf20a and the changes in their expression after acute kidney injury induced by gentamicin exposure. Quantitative real time polymerase chain reaction assays showed an increased expression of fgf mRNA transcripts immediately after injury. Interestingly, we detected localized fgf8a transcripts following injury using whole mount in situ hybridization in clusters of cells that resemble neonephric precursors, thus implicating a role for fgf8a in the regeneration response. Inhibition with SD5402, a robust fibroblast growth factor receptor competitive inhibitor, showed a decreased number of cells expressing the pax2a proliferation marker in preliminary immunohistochemical assays, suggesting that fgf signaling plays a role in stimulating regeneration in the zebrafish mesonephros. Future experiments will use transgenic and chemical genetic perturbations to modulate Fgf signaling during regeneration.

What inspired you to participate in undergraduate research?
I've been doing research since the Junior year of high school, initially comparing ENaC delta channels in differing species before moving to Malpighian tubules, the invertebrate counterpart to the vertebrate kidney, in cockroaches. After completing my independent research project my senior year, I joined the Wingert Lab the Spring Semester of my Freshman year to study the regeneration of zebrafish kidneys.

How did you get your research position, and what preparation did you undertake for it?
I began my lab experience by combing the Biology faculty website at the beginning of my Freshman year, noting down which professors I would like to speak to pertaining their research. After reading a few of their selected publications, I whittled down the list before e-mailing each professor individually, requesting a personal meeting to discuss the possibility of working in their lab. From there, I have stayed on campus over the summers to continue working for the Winger Lab, first through the generous funding of the lab the first semester, and then through the Glynn Honor Family and COS-SURF the second.

Where was your research experience located?
University of Notre Dame

What did you get out of your research experience?
I became more competent both at the bench and before the desk, being trained specifically to be able to perform certain delicate techniques such as mesonephros dissections, in situ hybridizations, quantitative real-time PCR, as well as the chance to create my own independent project to pursue during my remaining time at Notre Dame. So far, I have gained so much knowledge about the field of Immunology and how miRNAs are vital components of gene regulation for differentiation of immune cells. I also have learned many research techniques that will give me a solid base for future positions in research labs.

Positive Feedbacks in Global Biogeochemistry: Methane Emissions from Freshwater Lakes

Michael Kipp
Major: Biological Sciences
Advisor: William West, Dept. of Biological Sciences, University of Notre Dame

Freshwater inland lakes are a significant source of atmospheric methane (CH_4), and despite covering less than 1% of the earth's surface, lakes emit more CH_4 than the ocean. With freshwater lakes missing from many atmospheric circulation models, there is a need to quantify their potential climate impact. A positive feedback in the global climate has been observed, with CH_4 emissions from lakes increasing as lakes warm. The mechanism involves both an increased production of CH_4 in the littoral sediments, and increased diffusive efflux from warm surface water. Methane cycles in lakes were characterized over the course of a summer, and drivers of emissions were determined. Methane production, CH_4 storage, and lake surface area to volume ratio were determined to be reliable predictors of CH_4 emissions. Additionally, a strong correlation exists between lake productivity and emissions. This suggests that eutrophication may be an amplifier of existing global change mechanisms. Our findings have implications for both existing lakes in temperate and boreal zones, as well as newly forming glacial lakes and wetlands at higher latitudes.

What inspired you to participate in undergraduate research?
An intrinsic wonder about the Earth and a desire to better understand the processes by which life has colonized our planet.

How did you get your research position, and what preparation did you undertake for it?
I have been working in the Belovsky Lab since Fall 2011, which inspired me to apply for a Summer Environmental Research Fellowship to spend my summer at University of Notre Dame Environmental Research Center – East. Previous exposure to research made it easier to undertake my own project and cultivate it into something robust.

Where was your research experience located?
University of Notre Dame Environmental Research Center – East in Land O'Lakes, MI.

What did you get out of your research experience?
This research project gave me experience in fieldwork, data analysis and modeling, grant writing, and conference presentation. Most of all, the experience gave me a taste of what it will be like to conduct research in graduate school.

Microhabitat choice as a function of ectoparasitism:
basking behavior of* Chrysemys picta bellii *in the presence of* Placobdella *spp.

Julia Kruep
Major: Biology
Advisor: Matthew Michel, Dept. of Biological Sciences, Saint Louis University, St. Louis, MO

The "desiccating leech" hypothesis proposes that differences in ectoparasite load between basking and bottom-dwelling freshwater turtle species occur because leeches abandon hosts that spend lengthy periods of time basking out of water and exposed to the sun. However, recent research has suggested that leeches have simply evolved to avoid certain turtle species entirely based on the more favorable host environment provided by bottom-dwelling turtles. In order to further examine the validity of the "desiccating leech" hypothesis, the influence of *Placobdella* spp. leeches on the basking behavior of Western painted turtles (*Chrysemys picta bellii*) was investigated through a series of 3-day basking trials. Turtles were randomly assigned to three different treatment tanks: control, *Placobdella* spp., or *Macrobdella decora* (inert organism control). Results of an ANOVA indicated that no significant differences in basking behavior between treatments were observed over the course of the study. Baseline ectoparasite load for each turtle was also taken into consideration. Results of a linear regression analysis complemented the comparison across treatments; no significant relationship existed between baseline ectoparasite load and basking habits. These results support the idea that *Placobdella* spp. have instead evolved to selectively parasitize bottom-dwelling turtle species, regardless of individual basking behaviors.

What inspired you to participate in undergraduate research?
I was first interested in undergraduate research as a way to see if this is a direction I would like to take my career in. I have plans to go to veterinary school, but also wanted to explore how I might incorporate research. I specifically wanted to have a true field research experience.

How did you get your research position, and what preparation did you undertake for it?
I applied for the UNDERC-East Practicum in Environmental Field Biology, which is a 6-credit course with an independent research component. Before going to UNDERC, I also started as an undergraduate in the Archie Lab processing wild baboon fecal samples for a variety of parasites, which gave me a jumpstart into the research process and experience with bench work in the lab.

Where was your research experience located?
University of Notre Dame Environmental Research Center in Land O' Lakes, Wisconsin.

What did you get out of your research experience?
UNDERC-East is one of the most beautiful places I've ever been. Spending time developing, troubleshooting, and carrying out my own research project, while at the same time learning about different facets of field biology, was an amazing experience. As a pre-vet student, I was also able to incorporate hands-on animal experience, which is important for application to vet school.

Glycine Alteration By Cold Atmospheric Plasma

Emily Kunce
College of Science
Physics in Medicine
Advisor: Sylwia Ptasinska, Dept. of Physics, Notre Dame Radiation Laboratory,
University of Notre Dame

In recent years, the medical applications of plasma technology have been aimed at innovating the treatment and preparation of both indirect medical materials and direct physical tissues [1]. While it has been well understood for several years that large doses of plasma radiation can result in tissue necrosis and localized inflammation, recent research efforts have focused on low-dose plasma treatments that may lead to enhanced or repressed cellular function [1]. While the qualities of current plasma technology lend itself to dermatological treatment, the reactive species found in cold atmospheric pressure plasma are also being widely investigated as apoptosis-inducing agents in cancer cells when they are introduced to tissues in such low doses [1]. While these mild plasma treatments are highly targeted, they may still have effects on local healthy cells that surround the cancerous areas. To investigate these potential side effects, this research aims to develop an understanding of the effects of helium plasma radiation on the bonds within the simplest amino acid, glycine, and any changes in the structure of the molecule.

In the present study, 0.5M solutions of glycine in distilled water are prepared and then irradiated in glass sample dishes; trials of single samples are subjected to short plasma treatments of length 1 minute, 3 minutes, 5 minutes, and 7 minutes. The treated solution is then recovered, with the volume evaporated recorded. The irradiated samples are then analyzed immediately using Fourier Transform Infrared Spectroscopy (FTIR); then, the samples are refrigerated overnight and another FTIR spectra is recorded so that the bond changes at both 0 hours and 24 hours post-irradiation can be investigated.

In FTIR spectroscopy, the glycine molecule is characterized by four strong peaks found at wavenumbers of 1603 cm-1, 1507 cm-1, 1416 cm-1, and 1331 cm-1 [2]. Preliminary results from initial trials indicated that prolonged exposure to the plasma jet resulted in increased absorbance of the four primary peaks, in addition to increased noise in the spectra. Additionally, more recent trials have been conducted in a matched-pairs design using helium-controls to determine the precise effect of the plasma treatment separate from the possible effects of the helium gas flow. In these spectra, the irradiated glycine shows five strong primary peaks and changes in smaller fingerprint peaks, meaning that an additional bond interaction may have been formed during treatment that isn't present in healthy, irradiated glycine. These matched investigations have only begun to be analyzed; yet further analysis and trials will be conducted to verify these initial claims.

[1] von Woedtke, Th, et al. "Plasmas for Medicine." Physics reports 530.4 (2013): 291-320. Print.
[2] "Quantitative Assessment of Amino Acid Damage upon keV Ion Beam Irradiation through FTIR Spectroscopy." Plasma science technology.3 (2010): 378-84. Print.

What inspired you to participate in undergraduate research?

I loved being able to have to opportunity to apply the theories and concepts that I was learning in class to a problem that affects the real world outside of textbooks and exams, and also to make a difference in possibly the future of the field at the same time. It also helps me understand the things I learn in class because it relates the ideas to physical, measurable results and data that you can see and understand in a contextual setting.

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

I got my research position at the end of my senior year of high school when I asked Notre Dame faculty that I met during my visitation weekend here if I could do my required internship with them. What started out as a two week long shadowing period turned into an offer to do research with the group when I arrived at Notre Dame that fall and I've been a member of Sylwia Ptasinska's plasma lab ever since!

(May 2012). Basically, my first few months in the lab consisted of a lot of reading and listening to talks in order to amass the necessary background knowledge to carry out and understand experiments, in conjunction with the required safety training and certifications as well.

Where was your research experience located?
Radiation Laboratory, University of Notre Dame

What did you get out of your research experience?
My research is still ongoing, but I've gained a working and more applicable knowledge of physics, biology, and chemistry through my work in the plasma lab because of its integration of biophysics and chemistry. I've also learned valuable data analysis skills, practice at presenting professionally in front of a crowd (during COS-JAM), and how to work and collaborate with a group on a large, long-term project.

Characterization of Ag SERS-active microelectrodes

Daniel Kwasnieski
Major: Chemistry and ACMS
Advisor: Zachary Schultz, Dept. of Chemistry and Biochemistry, University of Notre Dame

Redox processes occurring on catalytic surfaces are important in many industrial and research applications. However, catalyst poisoning results when molecules or reaction products irreversibly bind to the surface and impede the chemical reaction involving the catalyst. This is a persistent problem affecting the efficiency of these reactions. Understanding the mechanism that leads to the desired redox product or the poisoning phenomenon may be aided by single-molecule studies on catalytic surfaces. Our approach focuses on developing and characterizing Ag microelectrodes as a platform for combined surface-enhanced Raman spectroscopy (SERS)-electrochemical studies with sufficient sensitivity for single-molecule detection. The Ag electrodes are constructed by electrolytically depositing Ag on a Cu electrode, with different Ag morphologies resulting from varied electrolysis times and initial surface topography. By controlling the surface energy electrochemically, we can monitor redox processes occurring on the electrode surface. The SERS enhancement factors (EFs) of these substrates are calculated by comparing the Raman signal intensity of thiophenol adsorbed to the Ag substrates to that of neat thiophenol. The EFs can then be correlated to the various morphologies produced from varying the electrolysis time, and the substrates with the largest reproducible EFs can be selected for use in future SERS-electrochemical studies of single-molecule redox reactions.

What inspired you to participate in undergraduate research?
I really wanted to get involved with actual science and not just sit in a classroom all day learning from a professor and a book. There is so much cool stuff going on in the world of research that it just is not possible for you to learn it all by going to class, and I figured getting hands-on experience with doing science would be a great way to learn a lot.

How did you get your research position, and what preparation did you undertake for it?
To get my position, I emailed a few professors around campus who were doing work that seemed interesting to me and set up appointments to meet them and see their labs. I was offered a position at each of them and picked the one that seemed to fit me the best. All I had to do was take two easy safety courses to become qualified to perform research.

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

What did you get out of your research experience?
I learned a lot from my experience, not just in that specific field of chemistry but also about science and the scientific process in general. It is easy to open a book and see a chemical reaction or a picture of cell and just take it for granted that it is right, but when you have to actually figure out why the reaction proceeds the way it does or why the cell is organized in that way, the problem becomes much more real, and I very much enjoyed the challenge of research.

Untargeted Metabolomics Examine the Effects of Ascorbic Acid and Glyceryl Trinitrate in C_2C_{12} Skeletal Muscle Cells

Eunice Lee
Major: Biological Sciences
Advisor**:** Jan F. Stevens, Jaewoo Choi, Cristobal L. Miranda,
Linus Pauling Institute and College of Pharmacy, Oregon State University, Corvallis, OR

Glyceryl Trinitrate (GTN) has been used to treat angina pectoris, acute myocardial infarction, hypertension, and other cardiovascular diseases due to its vasodilatory effects resulting from the release of nitric oxide (NO). However, prolonged treatment of GTN is known to develop nitrate tolerance. Ascorbic acid (AscH) is an antioxidant that is predicted to prevent nitrate tolerance by scavenging free radicals and superoxides and/or preventing inactivation of aldehyde dehydrogenase, which is the enzyme that catalyzes bioactivation of GTN. Currently, the underlying mechanisms are not fully understood, but the present metabolomics study in mouse C2C12 skeletal muscle cells, which cannot synthesize AscH, may help understand the metabolic pathway, including the mechanisms of nitrate tolerance, and the protective effects of AscH. In our previous study, we found that vitamin C deficiency activates the purine nucleotide cycle (PNC) in zebrafish. AscH deficiency leads to oxidative stress and to increases in the metabolites of PNC: guanine, AMP, ADP, and GMP. Our present study showed that exposure to mouse skeletal muscle cells to vitamin C (0.5 mM), with or without co-treatment with GTN (10 μM) caused a marked increase in the intracellular levels of hypoxanthine. This finding suggests that vitamin C plays an important role in PNC in mammalian cells to keep the pool size of ADP small by converting it to hypoxanthine via inosine monophosphate (IMP) and/or inosine.

What inspired you to participate in undergraduate research?
I love using the education learned from lectures and the scientific techniques used in labs for practical application in the real world to solve and answer real problems. Since I was interested in vitamin C and its effects on human bodies, I thought I would seize the opportunity to work in a research lab that studied micronutrients, such as vitamin C, to prevent and treat cancer and cardiovascular diseases.

How did you get your research position, and what preparation did you undertake for it?
Since it was the first time I researched in a lab, apart from classes, I didn't know how to apply for a research position. After looking online for research projects concerning my interest in vitamin C, I was able to stumble upon the research done at the Linus Pauling Institute. All the research concerned medicinal chemistry and research, which intrigued me enough to email the principal investigator in hopes of getting a summer research position. With a thorough explanation of my interest in the field, I was able to get the position and immediately submitted a research proposal to The Center For Undergraduate Scholarly Engagement and the First Year of Studies to provide funding for my research.

Where was your research experience located?
Linus Pauling Institute at Oregon State University.

What did you get out of your research experience?
Through this research experience, I was able to meet new friends and collaborators, have insight into the medicinal chemistry and biochemistry field, and enjoy the wonderful city of Corvallis. A whole month of staying at a completely new place really helped me to grow independently as a person. As a research, I learned how to culture mammalian cells, run a MTT assay to check cell viability, work with mass spectrometer, analyze target/untargeted metabolites to understand metabolomics pathways by using chromatographic and statistical software programs, such as Peakview® and Markerview®, and learning how to read research papers to see their correlation to my own study. My research experience at the Linus Pauling Institute provided me with basic skills necessary to conduct research in the biomedical field.

Novel Cdc42 Knockout Model Reveals Critical Role for Cdc42 During **in vivo** *Mammary Gland Morphogenesis*

Matthew Mattera
Major: Biology
Advisor: Tracy Vargo-Gogola, Dept. of Biological Sciences, University of Notre Dame
and Indiana University School of Medicine – South Bend
Coauthors: Kristi Bray and Alisa Blumenthaler

Cdc42 regulates key cellular processes necessary for mammary gland (MG) development, and is shown to be overexpressed and hyperactivated in breast cancer. The role of Cdc42 during normal MG development and mammary tumor formation *in vivo* remains unknown. To address these questions, our lab created a novel MG selective Cdc42 conditional knockout (KO) model to create a mosaic KO of Cdc42 in ~60% of MECs. This model includes a dual fluorescent reporter, which marks wildtype cells with RFP and KO cells with GFP. MGs from the Cdc42 KO mice have a significant reduction in GFP positive cells (≈50%) compared to controls. Despite this decrease, the structure and morphology of the KO gland is relatively normal which suggests the Cdc42 KO cells are at a competitive disadvantage to neighboring wildtype (WT) cells and the WT cells may be dividing more to compensate for defects in the Cdc42 KO population. 3D culture analysis revealed that KO mosaic acini, consisting of GFP-/WT and GFP+/KO MECs, had increased proliferation in the GFP- cells compared to control. These data support the hypothesis that WT cells are proliferating more to compensate for their impaired neighboring KO cells and that Cdc42 KO cells are impaired in their ability to contribute to MG development *in vivo*.

What inspired you to participate in undergraduate research?
I had an interest in doing research ever since I became aware that the opportunity existed. I couldn't turn down the chance to make discoveries, especially in a field like breast cancer research where the goal is finding a cure for a terrible disease. The Vargo Lab welcomed me in the spring of freshman year, and I've been working there ever since.

How did you get your research position, and what preparation did you undertake for it?
Spring of 2012 I took a class, Introduction to Undergraduate Research. A small group of students including myself chose to perform experiments under the guidance of Dr. Vargo in her lab. The next summer I volunteered in the lab, and in the fall I began working for academic credit. After submitting a research proposal based on the research I had been doing during my sophomore year, the Glynn Family Honors Program and the College of Science provided funding for me to continue the project during this past summer.

Where was your research experience located?
Indiana University School of Medicine, South Bend.

What did you get out of your research experience?
I had a wonderful summer here at Notre Dame. Working with other students in the lab was a blast, and learning new techniques (like mice dissection) was valuable and interesting. Working in the lab this past summer helped me become the Lab Technician in the Vargo Lab which has since been an exceptionally rewarding experience. My research with the Vargo Lab has provided a foundation for my future studies in the field of breast cancer research. Hopefully, the knowledge and skills I've gained from my research experiences will help me in medical school.

Antimicrobial Action of Microbes Associated with the Epidermal Mucus of Mobula hypostoma *and* Rhinoptera bonasus

Joseph Mueller
Major: Biology
Advisor: Kimberly Ritchie, Marine Microbiology, Mote Marine Laboratory, Sarasota, FL

The epidermal mucus of aquatic species presents a potential source for novel medicines to combat human wound infection pathogens. Due to their low rates of infection in the wild, stingrays present an especially compelling subject for this research. This study characterized the antimicrobial properties of commensal bacteria within the stingray epidermal mucus layer. We hypothesized that several bacterial isolates would display antimicrobial activity, and that antimicrobial compound production would be upscaled through UV mutagenesis of active isolates. Culture libraries of mucus isolates from two stingray species, *Mobula hypostoma* and *Rhinoptera bonasus*, were overlaid with six tester pathogens to screen for antimicrobial activity. Isolates displaying activity were then exposed to UV irradiation to attempt to upscale production of antimicrobial compounds. Further characterization of active isolates was carried out through blood agar and Proteinase K assays. In total, seven isolates displayed antimicrobial activity, with two showing broad spectrum pathogen inhibition. After exposure to UV light, four colonies appeared to increase antimicrobial activity relative to controls, although further tests would be required for conformation. Eleven isolates were further analyzed, with seven showing hemolytic activity and four appearing to be inhibited by Proteinase K. One isolate displayed neither hemolytic activity nor inhibition by Proteinase K. This final isolate presents a compelling candidate for further research into its antimicrobial compound for potential use in human medicine. In addition, this study presents additional evidence that bacterial symbionts extant in stingray epidermal mucus contribute to the innate immunity of these organisms.

What inspired you to take part in undergraduate research?
I was inspired to take part in research based on the great experience I had in my undergraduate biology labs. I've also always been interested in marine biology, and this opportunity allowed me to explore those interests further.

How did you get your research position, and what preparation did you undertake for it?
I obtained my research position by applying for an NSF funded Research Experience for Undergraduates offered at Mote Laboratory. I prepared by making contact with my mentor to discuss my project and reading literature relevant to the marine microbiology field.

Where was your research experience located?
Mote Marine Laboratory in Sarasota, Florida

What did you get out of your research experience?
I gained my first experience in marine biology, an amazing and interesting field! I also established friendships with peers and researchers within this field. Furthermore, my research made me much more comfortable working in a lab environment and provided practice in scientific writing through both the application and presenting processes.
Mumme

Elevated Lung Endostatin mRNA Expression and Impaired Angiogenesis in Down Syndrome

Dominique Nguyen
Major: Science Preprofessional Studies
Mentor: Steve Abman, Pediatric Heart Lung Center, University of Colorado-Denver, Denver, CO

Down Syndrome (DS), or Trisomy 21, is associated with severe pulmonary diseases including pulmonary hypertension, recurrent pneumonia, respiratory failure, and poor exercise tolerance that contribute to early death and morbidities in DS children. Endostatin (ES) is a potent anti-angiogenic factor derived from the soluble 20 kDa C-terminal fragment of collagen XVIII, encoded by the *COL18A1* gene. Since the ES gene is present on chromosome 21, babies diagnosed with DS may have increased ES expression. Although increased anti-angiogenic agents may benefit against the onset of tumor angiogenesis in DS patients, it may also adversely affect lung structure due to impaired vascular and alveolar growth. Biological mechanisms contributing to pulmonary disease in DS are poorly understood, but abnormal lung angiogenesis may increase the risk for postnatal disease. Testing this hypothesis, we measured and found markedly increased lung ES mRNA in DS prenatal and neonatal lungs when compared to normal. In addition, we noted abnormal lung architecture in DS children. Studying the effects of ES on vascular growth *in vitro,* we found that ES inhibits human microvascular pulmonary endothelial cell (HMPEC) migration supporting the hypothesis that ES negatively affects pulmonary cell function. Ongoing studies seek to clarify the physiological impact that increased ES mRNA expression has on the developing DS lung. Furthermore, biochemical analysis of the relationship between ES activity and DS lung angiogenesis is now being approached in hopes of finding a way to prevent the risk for lung disease in DS babies.

What inspired you to participate in undergraduate research?
After working as an assistant in a biological lab (Lamberti), I became interested in how the biological concepts I was learning in the classroom could be put into experiment and applied to the natural world around me.

How did you get your research position and what preparation did you undertake for it?
I sent in my application through Notre Dame to the Webb-Waring biomedical summer research internship program. This program rewarded me a National Institutes of Health (NIH) grant to do biomedical research for 10 weeks.

Where was your research experience located?
University of Colorado-Denver, Anschutz Medical Campus

What did you get out of your research experience?
This program not only exposed me to the amazing field of biomedical research, but also to the different aspects of medicine and different kinds of medical professionals, which solidified my desire to become a physician. I learned the importance of translational research and made some of the greatest connections in my life.

Using Yeast as a Biosensor for Mutagenicity

Joseph Ong
Major: Chemistry
Advisor: Holly Goodson, Dept. of Chemistry and Biochemistry, University of Notre Dame
Coauthors: Julia Philip

The rise in the production of novel chemicals has resulted in a need to reliably determine the carcinogenic potential of compounds. Most of the current tests for mutagenicity are time-consuming, expensive, require special training and equipment, and are performed at concentrations of mutagen much higher than expected levels of human exposure. We investigated using yeast grown in a series of parallel continuous cultures as an inexpensive, easy-to-perform, and sensitive test for mutagenicity. Yeast was grown in varying levels of suspected mutagen and the mutagenic potential of the compound was analyzed by a mutagenic assay and will be analyzed by whole-genome sequencing. Mutagenicity of a compound can be inferred by comparing the number of surviving (mutant) colonies grown on a plate with canavanine, a chemical toxic to WT yeast. We have found that the canavanine-based assay provides data which can be used to determine the mutagenic potential of a compound. Whole-genome sequencing will provide a thorough analysis on the mutagenic potential of a compound. We hope to continue to explore the effects of mutagens on cells at low concentrations and over long periods of time and that using yeast as a biosensor will be implemented in the various tests for mutagenicity.

What inspired you to participate in undergraduate research?
I wanted to learn more about how research is conducted at the higher education level. Also, I thought that research would be a good way to apply what I was learning in class and a good way to become involved in a field outside my major.

How did you get your research position, and what preparation did you undertake for it?
I have been a member of the Goodson lab since June, 2013. I had no prior experience with doing research at a professional level, but I started emailing and talking to professors whose research projects interested me in the middle of the Spring 2013 semester. Dr. Goodson offered to meet with me, and, after reading various academic papers and discussing her research, she offered me the opportunity to work on a project that we thought would be a good introduction to lab work and research.

Where was your research experience located?
University of Notre Dame

What did you get out of your research experience?
One of the most important things I have learned from my research experience thus far is how to think: how to collect data, find trends within the data, analyze these trends, and draw conclusions from the data. That might seem straightforward, but finding clean, easy-to-interpret data is a rare gem, and figuring out why the data is unclear and what factors need to be considered when interpreting the data is a real challenge.

Gene expression changes downstream of APC loss predict tumor phenotype

Andjela Pehar
Major: Science Preprofessional Studies
Advisor: Jenifer Prosperi, Dept. of Biological Science, University of Notre Dame, Indiana University School of Medicine – South Bend, and Harper Cancer Research Institute

The Adenomatous Polyposis Coli (APC) tumor suppressor is mutated or hypermethylated in up to 70% of human breast cancer cases. Our previous studies demonstrated that *Apc* mutation advances the MMTV-Polyoma Middle T Antigen (PyMT) model of breast cancer, with an increase in signaling downstream of focal adhesion kinase (FAK)/Src/JNK activation in MMTV-PyMT;$Apc^{Min/+}$ tumors. In addition, the majority of tumors that arose in the MMTV-PyMT;$Apc^{Min/+}$ animals were classified as adenosquamous carcinoma as compared to tumors from MMTV-PyMT;$Apc^{+/+}$ animals, which were solid carcinomas. Given the heterogeneous nature of these tumors, RNA was isolated from tumors with wild-type *Apc,* mutant *Apc* yielding solid carcinomas, and mutant *Apc* resulting in adenosquamous carcinomas. Quantitative real-time RT-PCR was performed to identify gene expression changes responsible for the altered tumor phenotype between tumors from mutant *Apc* resulting in the different tumor phenotypes. In parallel studies, triplicate samples of the MMTV-PyMT;$Apc^{+/+}$ and MMTV-PyMT;$Apc^{Min/+}$ cell lines were analyzed by real-time PCR for gene expression changes. Multiple changes consistent with the phenotypic and proliferative changes downstream of APC loss were identified, including changes in expression of cyclooxygenase-2 (COX-2). Furthermore, 3D cultures of the samples of the MMTV-PyMT;$Apc^{+/+}$ and MMTV-PyMT;$Apc^{Min/+}$ cell lines were plated in standard Matrigel and Growth Factor Reduced Matrigel to investigate the role of the microenvironment in gene expression. In parallel with the previous studies, RNA was isolated from the 3D cultures and analyzed for gene expression changes. The findings presented here indicate that APC-mediated gene expression changes can be used to predict tumor phenotype and potentially downstream therapeutic targets.

What inspired you to participate in undergraduate research?
Seeing first hand how research can play a vital roll in the eradication of such an awful disease as cancer has been major motivating factor for me. I wanted to get a hands on experience in investigating the intricacies of science.

How did you get your research position, and what preparation did you undertake for it?
I spoke with my Advisor about my desire to conduct research at the University. She informed me of new researchers coming to the Harper Cancer Research Institute. After reading Dr. Prosperi's published work, I contacted her and expressed my desire to be a part of her lab. Upon submitting my CV to her and meeting with Dr. Prosperi at the beginning of the Fall Semester in 2012, I was offered an undergraduate research position.

Where was your research experience located?
Harper Cancer Research Institute – University of Notre Dame and Indiana University School of Medicine – South Bend

What did you get out of your research experience?
I have developed my skills in the lab working with *in vitro* models and learned valuable experiences that come with development of research projects in confronting the frustrations of difficult-to-interpret results and the exhilaration of promising ones. More importantly, however, seeing the way in which the work of an individual lab or researcher becomes interwoven into the holistic understanding of a disease and its potential for overreaching positive effects on medicine, has transformed my perspective of scientific research. I have learned that breast cancer is not one disease, but rather one that is unique in different patients with particular biological and genetic causes. My experience in the lab has been important to me because it has truly transformed my view and understanding of the medical science.

Hyperoxia Induces an Alveolar Macrophage Phenotype Switch from M2 to M1 in Rats

Clayton Smith
Major: Anthropology Pre-Health
Advisor: John E Repine, Pulmonary Sciences and Critical Care Medicine,
University of Colorado-Denver, Denver, CO
Coauthors: Chelsea Viscardi, Amanda Agazio, Paul Wilson, Nancy Wilkins, Ana Fernandez-Bustatamente, and John E Repine

Acute Respiratory Distress Syndrome (ARDS) is a common and highly fatal syndrome that is characterized by an inflammatory exudate in the alveolar spaces. Following exposure to hyperoxia, rats develop ARDS characterized by rapid increases in neutrophils, macrophages, protein, and LDH concentrations in their lung lavages that occur after 52 hours and before death at 66 hours. There are two major phenotypes of macrophages found in the lung lavage: M1 and M2. The M1 phenotype induces a pro-inflammatory response, while the M2 phenotype induces an anti-inflammatory response. Using flow cytometry, we observed a macrophage phenotype switch that occurs from M2 to M1 in hyperoxia-exposed rats. This macrophage switch probably accounts for the acute lung inflammation and injury that occurs in rats following exposure to hyperoxia. Patients exposed to high concentrations of oxygen for an extended amount of time also can develop ARDS. If the macrophage switch can be prevented it might reduce the development of ARDS in patients who need oxygen for long periods of time.

What inspired you to participate in undergraduate research?
There are always stories in the news about new biomedical findings and how they may affect people's lives. I wanted to learn more about the community of scientists who are making these discoveries and the scientific processes involved.

How did you get your research position, and what preparation did you undertake for it?
I was fortunate enough to know Dr. Repine prior to working with him. After asking about a potential summer job working in his lab, he responded with an enthusiastic invitation. I was working in a lab that brings in students from Notre Dame, Yale, and Princeton. Notre Dame students apply to work in his lab at the end of the academic year.

Where was your research experience located?
University of Colorado Denver Anschutz Medical Campus

What did you get out of your research experience?
I developed a thorough understanding of the translational "benchtop to bedside" biomedical research process. On top of learning many research methods, I learned a lot about the scientific method: asking questions, designing an experiment to carry out, analyzing data, then making conclusions and repeating this cycle based on the obtained results. I learned that research can be tedious, but it can also be fascinating and rewarding. Finally, I met some incredible mentors and friends who I will remain in touch with. Dr. John E. Repine's summer program is one of a kind and extremely beneficial to any student wanting to learn more about research and medicine. The program focused one exposing students to the multi-faceted field of medicine, with research just being one aspect.

A Genomics Platform for Anti-Malarial Drug Research

Roger Smith
Major: Biological Sciences
Advisor: Michael Ferdig, Dept. of Biological Sciences, University of Notre Dame
Coauthors: Geoffrey Siwo, Asako Tan, and Lisa Checkley

Genomics technologies have greatly enhanced our understanding of the basic biology of the malaria parasite. However, malaria remains a global challenge, directly causing over 250 million infections and 1 million deaths annually. A rapid emergence of drug resistance threatens successful eradication of the disease. Understanding drug mechanism of action (MOA), the molecular basis of multi-drug resistance (MDR) and predicting effective and combinatorial drug interactions from genomics data is highly limited by current approaches. Here, we take a first step towards demonstrating the utility of genome-wide transcriptional responses of the malaria parasite to drugs targeting a diverse array of biological pathways in understanding drug MOA and predicting chemo-sensitivities. Using a high density, multi-sample gene chip developed in our lab, we demonstrate that the malaria parasite's response to small molecules produces characteristic gene expression signatures that are predictive of drug MOA. As a proof of concept, we show that the gene expression fingerprints of drugs with the same MOA are highly correlated to each other. In particular, we perturbed two strains of the malaria parasite using 10 different drugs targeting folate biosynthesis, heme detoxification, DNA repair, mitochondrial protein synthesis and electron transport. We then developed a simple heuristic that makes no assumptions on the induction/ repression of specific genes by a given drug but instead uses a genome-wide signature. Applying this method to gene expression response of the 2 laboratory strains, we correctly predict the expected MOA of six out of nine drugs whose primary MOA is known, compared to a random chance of 0.0002. We also develop computational methods to facilitate the de novo prediction of MOA and regulatory processes that mediate drug response using a gene network reverse engineered from an independent data set. We are extending this study to a series of over 30 compounds targeting diverse pathways in the malaria parasite with the goal of creating a reference resource and computational tools for the prediction of drug MOA.

What inspired you to participate in undergraduate research?
Interested in a career in medicine, I wanted to gain experience doing research that drives the field of medicine forward. I have since realized that I want research to always be a part of my career.

How did you get your research position, and what preparation did you undertake for it?
I spoke to my graduate TA in general biology lab about my interest to engage in undergraduate research and potential opportunities in the Ferdig Lab. I was afforded an opportunity to volunteer in the lab during the spring semester of my freshman year as a trial period, and I have worked in the lab since that time. Beginning so early, my primary 'preparation' was simply demonstrating a sincere interest in science and demonstrating that I am a determined, hard worker.

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

What did you get out of your research experience?
I have developed many professional relationships with members of the Ferdig Lab and collaborators. The skills I have gained in conducting research, writing proposals, and synthesizing results will be integral to my success as a physician scientist in the future.

Manipulating Atoms to Create Artificial Materials

Anna Stephenson
Major: Physics
Advisor: Kenjiro Gomes, Dept. of Physics, University of Notre Dame
and Hari Manoharan, Dept. of Physics, Stanford University, Palo Alto, CA

In order to develop new electronic technologies and advance material designs, there is an increasing demand to improve our control over the atomic design of nanoscale devices. In this research, we propose a new way to create artificial materials through the manipulation of single atoms and molecules. We design and build artificial electronic systems using a scanning tunneling microscope (STM). The STM allows us to move atoms one at a time to assemble lattices, allowing us to fine-tune the electronic properties of the system atom by atom. At our starting point, we investigate the electronic properties of an artificial graphene lattice, created by assembling carbon monoxide molecules on a copper surface. Graphene is unique in that its electrons behave like ultrafast particles. We demonstrate these properties and explore the versatility of our lattice to create exotic forms of strains that mimic the effect of a magnetic field. We plan to continue our work by applying this technique to other lattices where even more exotic electronic properties are present.

What inspired you to participate in undergraduate research?
The satisfaction of problem-solving inspired me. I like finding solutions to questions, especially if I can find an unusual or clever way to do it. I also like working with my hands and fixing things. An experimental lab gave me the environment to pursue these interests.

How did you get your research position, and what preparation did you undertake for it?
I applied and was accepted to a program at Stanford University, where my advisor at Notre Dame,. Kenjiro Gomes, did his post-doc. I was able to work in his old lab where I continued his previous work, so I could bring my findings back to Notre Dame and continue this project throughout my undergraduate years. I prepared for my summer research position by learning the material in the subject, and beginning preliminary analysis on data previously collected from the lab.

Where was your research experience located?
Stanford University in Palo Alto, CA

What did you get out of your research experience?
I learned so much about physics and experimental work, and I was able to interact with some truly exceptional faculty and students who gave me invaluable advice about being a student and a physicist. My research experience has left me inspired to continue my work, and assured that I enjoy research.

Understanding the binding mechanism of VU0404251, a positive allosteric modulator of metabotropic glutamate receptor 5 a novel target for treatment of schizophrenia and cognitive disorders

Jessica Zic
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Allosteric modulators affect the activity of G protein-coupled receptors (GPCRs) at sites that are topographically distinct from the orthosteric binding site of the endogenous ligand. Positive allosteric modulators (PAMs) enhance the affinity and/ or efficacy of orthosteric agonists. PAMs for the GPCR metabotropic glutamate receptor 5 ($mGlu_5$) have shown potential for treatment of cognitive disorders and schizophrenia. VU0357121 and VU03060172 are PAMs of $mGlu_5$ at different allosteric sites. VU0404251 is a structural hybrid of VU0357121 and VU03060172, but the binding site of VU0404251 was unknown. The goal of these studies was to analyze the activity of VU0404251 in mutant and wild-type mGlu5-expressing HEK293A cells and compare this activity to that of the VU0357121 and VU03060172. Intracellular Ca^{2+} mobilization assays were performed to determine the peak response elicited by the glutamate after VU0404251 was added. The results showed that the mutant profiles with respect to affinity of VU0404251 and VU0360172 were similar with some overlap with the VU0357121 mutant profile. Comparisons of the VU0404251, VU0306172, and VU0357121 binding mechanisms will assist in the computational modeling of the $mGlu_5$ receptor and promote the discovery of novel mGlu5 PAMs for the treatment of cognitive disorders and schizophrenia.

What inspired you to participate in undergraduate research?
I am fascinated by neuroscience and the pursuit of novel answers to scientific questions.

How did you get your research position, and what preparation did you undertake for it?
I worked in the Conn Lab the summer of 2012, and Dr. Conn recommended I apply to the Vanderbilt Summer Science Academy for the 2013 summer. In order to participate in the Vanderbilt Summer Science Academy I submitted a statement of purpose, applied for a Summer Undergraduate Research Fellowship, and had my professors write recommendation letters on my behalf.

Where was you research experience located?
Vanderbilt University

What did you get out of your research experience?
An exciting summer with new friends and incredible scientists! I also learned how to pursue an independent research project and how to present my research to my peers. My research experience in the Conn Lab provided me with a great foundation for my future scientific studies.