FALL UNDERGRADUATE RESEARCH FAIR

ABSTRACT BOOK

Thursday, October 29, 2015
Jordan Hall of Science
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 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!

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Career Center (careercenter.nd.edu)

The Career Center provides undergraduate students with career counseling and career development services, self-assessments, workshops, presentations for academic departments, career fairs, and mock interviews, in addition to other services. We encourage students to take ownership of their career direction, and be willing to devote the time and energy necessary to conduct a successful search for jobs, internships, fellowships, and/or the identification of graduate school programs. Students have the opportunity to utilize our online databases, including Go IRISH, to pursue postgraduate opportunities, sign up for interviews, and conduct career-related research.

Contact: Robyn Centilli (Robyn.O.Centilli.1@nd.edu) and Justin Rice (jrice4@nd.edu)

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

NDnano is a world-class, collaborative research center that includes faculty from seven departments across the colleges of Engineering and Science. The Center is focused on developing, characterizing, and applying new nanotechnology-based materials, processes, devices, and solutions that will better society. 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 2016 will mark the NURF program's eighth year. To date, more than 175 students from Notre Dame and several other universities have participated in the program, gaining valuable research skills and experience. The 2016 application process will open the first day of classes in January.

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 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, National Science Foundation Graduate Research Fellowship, Truman Scholarship, and Goldwater Scholarship.

Contacts: Yvonne Mikuljan (ymikulja@nd.edu) and Jeffrey Thibert (fellows@nd.edu), Assistant Directors.

Dinners for Increased Scholarly Communication (DISC)

DISC is a student-run program with the mission of increasing intellectual engagement in the College of Science by fostering student-faculty interactions. Funded by the College of Science, the group organizes Sunday night dinners at the homes of science faculty members. Typically, eight students are invited to attend and take part in more relaxed conversation than what may occur in the classroom. DISC hopes to increase the ease with which students approach their professors regarding classroom material, career paths, or research opportunities.

Contact: Zoe Volenec (zvolenec@nd.edu), and Aaron Tarnasky (atarnask@nd.edu)

DNA Learning Center (dnacenter.nd.edu)

The DNA Learning Center is hands-on learning center dedicated to non-scientists of all ages. There are many ways for Notre Dame students to get involved including volunteering, summer camp employment, and independent research. Notre Dame students have the opportunity undertake research projects with the dual goal of learning strong research skills and becoming a mentor for high school students undertaking research projects. Research projects focus on a variety of topics within the field of genetics including biomedical applications.

Contact: Amy Stark (astark1@nd.edu), Director of the DNA Learning Center.

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

ND Energy is a University Research Center whose mission is to foster and grow energy-related research towards sustainable and affordable energy solutions, support energy-related education and outreach throughout the Notre Dame and surrounding communities, and influence the national and global discussions of the most pressing energy policy issues and questions of our time. A high priority for ND Energy is to engage undergraduate students in energy-related research and educational opportunities. This is accomplished through programs such as the Slatt Fellowships for Undergraduate Research in Energy Systems and Processes, the Energy Studies Minor, which is open to students in all majors, and the Student Energy Board. These programs are designed to prepare undergraduate students to become successful researchers and leaders with the abilities to develop better energy systems and devices, understand the complexities of society’s energy challenges, and make a difference in our global energy economies.

Contact: Barbara Villarosa (bvillaro@nd.edu), Administrative Services Program Manager, or Anne Berges Pillai (apillai@nd.edu), Education and Outreach Program Coordinator.
Notre Dame Environmental Change Initiative (environmentalchange.nd.edu)

The Notre Dame Environmental Change Initiative (ND-ECI) is tackling large scale environmental challenges such as land use, invasive species, and climate change. The goal of ND-ECI is to provide solutions that minimize the trade-offs between human welfare and environmental health, and to discover win-win solutions where they are possible. Our faculty are from many academic departments and colleges, and work together to provide translational, applicable solutions to answer society's grand environmental challenges. Undergraduate students working with ND-ECI faculty have the opportunity to take advantage of our Linked Experimental Ecosystem Facility (ND-LEEF), located a few miles north of campus at St. Patrick’s County Park. ND-LEEF is a globally unique research facility that is home to two constructed experimental watersheds and over 20 acres of land available for terrestrial research projects. Each experimental watershed consists of an interconnected pond, stream and wetland which can each be manipulated to test ecological hypotheses. Through ND-LEEF, undergraduates would also have the opportunity to participate in a very engaged education and outreach program with K-12 and adult learners across the community. In addition, ND-ECI in partnership with the Center for Research Computing houses the Geospatial Analysis Laboratory (GAL) to connect the ND Community with Geographic Information Systems and Remote Sensing (GIS/RS) technology and resources. ND-ECI is also home to the Global Adaptation Index (ND-GAIN), the world’s leading Index showing which countries are best prepared to deal with global changes brought about by overcrowding, resource-constraints and climate disruption. The Index ranks 177 countries annually based on how vulnerable they are and how ready they are to successfully implement adaptation solutions. It includes analytic tools for examining trends, playing out scenarios, and investigating components over time. The ND-GAIN team is now working at the city level as well. To date, ND-ECI has funded over 50 undergraduates to work with faculty and staff on research and projects related to the current programs in environmental change. For more information on the faculty, research, and resources of ND-ECI, please visit our website environmentalchange.nd.edu/.

Contact: Joanna McNulty (jmcnulty@nd.edu), Business and Program Manager or Brett Peters (brett.w.peters.48@nd.edu), Assistant Director of ND-LEEF

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 $1000 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), Director of ND Ignite.

Harper Cancer Research Institute (HarperCancer.nd.edu)

Investigators in the Harper Cancer Research Institute (HCRI) are dedicated to conducting innovative and integrative basic cancer research that confronts the complex challenges of cancer. HCRI utilizes an interdisciplinary approach to cancer research. Students in our labs work across
scientific fields on project collaborations. Over sixty HCRI faculty members bridge 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. Research cures cancer.

Contact: Angela Cavalieri (cavalieri.2@nd.ed), External Relations and Special Events Program Coordinator.

**Hesburgh Libraries (library.nd.edu)**

The Hesburgh Libraries system is a diverse system comprised of the main Hesburgh Library and eight branch libraries, including 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. In addition, the Hesburgh Libraries’ Center for Digital Scholarship (CDS) leverages digital library expertise (e.g., GIS, data management planning, and statistical analysis) and state-of-the-art technologies (such as LaTeX, R, and MATLAB) to help manage and accelerate the research process.

In an effort to further its core mission of “connecting people to knowledge,” the Libraries offer a vast array of expertise, services, resources and spaces to ensure the academic success of the undergraduate student community. Whether through the expertise of subject librarians and specialty services or the access to various sources of knowledge, we continuously evolve to meet the ever-changing needs of students in the 21st century.

The Hesburgh 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 through individual consultations, or library workshops and in-class instructional sessions. In addition, we offer Undergraduate Library Research Awards (ULRA) program designed to honor students who best leverage the integrated suite of library services throughout their research process.

Learn more:

Hesburgh Libraries: library.nd.edu
Center for Digital Scholarship: library.nd.edu/cds
Contact your subject librarian: library.nd.edu/subjects
Download Subject Librarian Guide: http://library.nd.edu/about/subjects/Selectors.pdf
Ask-A-Librarian Service: asklib.nd.edu
Register for a workshops: http://library.nd.edu/about/workshops.shtml
Undergraduate Library Research Award: library.nd.edu/ulra

**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 is located on the corner of Angela Blvd. and Notre Dame Avenue across from the main entrance to the University of Notre Dame (UND) campus. Our 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 http://medicine.iu.edu/southbend/research/research-faculty

Contact: Jenifer Prosperi, PhD (jprosper@nd.edu or jprospe@iupui.edu), Assistant Professor

**Innovation Park at Notre Dame (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 over 250 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, extensive research training and marketable skills that will benefit the student's eventual career choice, either in a start-up or existing business. For more information on the Park and its clients, check out http://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 (kcruse@nd.edu), Assistant Director.

**Kellogg Institute**

The Kellogg Institute is an international research institute that focuses on democracy and human development. To engage undergraduate students in its mission, the Institute offers a variety of programs including funded internships, research grants, and fellowships. Students can receive
funding to go to Africa, Asia or Latin America during the summer. Information regarding all of these programs can be found at http://kellogg.nd.edu/students/index2.shtml

Contact: Holly Rivers (hrivers@nd.edu), Assistant Director or Rachel Thiel (rthiel@nd.edu), Program Coordinator.

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

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 (b hellent@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.

**ND International (international.nd.edu)**

International research is alive and well at Notre Dame International. Semester or academic year long programs, especially in Ireland and Australia, have a history of offering excellent undergraduate research opportunities while exploring a new culture in the classroom. NDI also facilitates international travel expertise for all ND students, faculty and staff with an on-line registration and travel resources. Susan Soisson will also be on hand to answer questions on the travel registration process for international ND sponsored travel. Representatives from NDI look forward to discussing international opportunities with you!
Of special note, three students will be presenting at the fair on their research done while studying abroad at University College Dublin. Savannah Kounselis (Investigating Different Cell Lines in Modeling Cystinosis) and Kelly O'Shea (Mitochondrial Protein Release During Programmed Cell Death) and Emily Fortner, (‘Neuroprotective effects of cannabidiol on LTP in an in vitro model of Alzheimer’s disease: Possible effects via the 5HT1A receptor inC57Black6 mice’)

Contacts: Kathleen Opel, Director of Study Abroad (kopel@nd.edu), Paula Worhatch, Notre Dame International (NDI) Office Manager (pworhatch@nd.edu), and Peggy Weber, Associate Director, NDI Study Abroad (mweber@nd.edu). All offices are in 105 Main Building (574-631-1138).

NDiscovery
This is an innovative web-based platform connecting students with College of Science research mentors. The purpose of the site is to connect passionate students with research faculty who have availabilities in their lab. The NDiscovery team is currently interviewing faculty, and collecting information about faculty members’ projects to share that information on a website where undergraduate students can discover all of the research being done within the College of Science. The site is designed to streamline the student-faculty matchmaking process by way of translating the technical jargon of publications to something more comprehensible for all to understand. If you are interested in joining this endeavor to launch the site by Spring 2015, or have any questions regarding the project, please stop by the booth tonight!

Contact: Nicole Handa (nicole.s.handa.1@nd.edu), Aly Anton (aanton@nd.edu), Luke Hamel (lhamel@nd.edu), and Matthew Grothaus (mgrothau@nd.edu).

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: Kaitlin Jacobson (kjacobso@nd.edu) and Michael Dinh (mdinh@nd.edu), Editors.

Minor in Sustainability
The minor in sustainability is open to Notre Dame students in all majors and colleges. Through a multidisciplinary approach, the minor prepares students to serve as leaders in their communities - local, national, and international - by making constructive and substantive contributions to the development of more sustainable practices for the benefit of their own personal and professional lives, the lives of others, and the lives of future generations. The minor also supports undergraduates, graduate students, and faculty who are interested in conducting research in sustainability by connecting them with relevant community partners, government agencies, and national and international research programs.

Contact: Rachel Novick (rnovick@nd.edu), Director.
University of Notre Dame Environmental Research Center (UNDERC, underc.nd.edu)

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, David Flagel (dflagel@nd.edu), Assistant Director-West, and Gary Belovsky (belovsky.1@nd.edu), Director.
Research Abstracts
Diel flight activity behavior of wild caught Anopheles farauti s.s. and An. hinesorum malaria mosquitoes from northern Queensland, Australia

Dominic Acri
Major: Neuroscience and Behavior
Advisor: Giles E. Duffield, Dept. of Biological Sciences, University of Notre Dame
Coauthors: Gary F. George, University of Notre Dame; Aaron D. Sheppard, University of Notre Dame; Nigel W. Beebe, University of Queensland, CSIRCO Ecosystem Science, Queensland; Scott A. Ritchie, James Cook University; and Thomas R. Burkot, James Cook University.

Species in the Anopheles farauti complex are major malarial vectors in the Asia Pacific region. A behavioral study of trap-caught mosquitoes in Queensland, Australia was conducted to investigate the differences in diel flight activity between two species and several reproductive states. 24-hour flight activity was monitored in individual adult female mosquitoes under light:dark cycle conditions using an infrared beam break method. For statistical analysis, data were arranged into time-bins, plots of activity accumulation, and z-scored. Species-specific differences and a species difference at one reproductive state were observed. Compared to An. farauti s.s., An. hinesorum mosquitoes had an earlier dusk activity onset, an earlier peak in nocturnal activity, and a higher level of activity at the onset of darkness. A second nocturnal peak in inseminated nulliparous An. hinesorum was also observed. The species differences between these major malarial vectors of the An. farauti complex might contribute to subtle differences in habitat adaptation and/or reproductive isolation. This study provides baseline data for analysis of populations of mosquitoes from other geographic regions, such as the Solomon Islands. This is important as selective pressures have and continue to occur using residual insecticides and insecticidal-treated bednets, and can shape the nocturnal profile of biting behavior.

What inspired you to participate in undergraduate research?
“As a neuroscience and behavior major, I am passionate about exploring the practical applications of behavioral research as a way to eliminate the threat of vector-borne diseases.”

How did you get your research position, and what preparation did you undertake for it?
“I have been a member of the Duffield Laboratory since Fall of 2014. I had previously heard Dr. Duffield lecture about his research area, during a summer program I was involved in here, and asked for him to guide me through my first undergraduate research experience.”

Where was your research experience located?
“University of Notre Dame”

What did you get out of your research experience?
“After spending a summer on campus, I was able to learn cutting edge laboratory techniques, the best way to perform large scale data analysis, and I had the opportunity to learn about the process that goes into writing a journal article. These are just some of the many skills that came out of my research experience.”
Responses to anthropogenic noise by urban and rural bird species

Natalie Ambrosio
Major: Environmental Science
Advisor: Kerri Citterbart Martin, Dept. of Biological Sciences, University of Notre Dame

Background noise disrupts birds’ communication and affects their success in areas of high human activity. While birds of the same species sometimes differ in separate habitats, all members of certain species also share traits regardless of location. Such traits predispose some species to live in urban habitats. One of these traits may be a greater tolerance to anthropogenic noise. At the University of Notre Dame Environmental Research Center near Land o’ Lakes, Wisconsin, I studied calling responses to anthropogenic noise in bird species that live exclusively in rural areas and those that thrive in both rural and urban locations. From examining the time it took birds to resume calling and the decrease in call rate after noise treatments, I determined the overall effect of anthropogenic noise and the difference in its effect on urban and rural species. Overall, the birds did not show a significant response to anthropogenic noise treatments, though there was significant interaction between noise treatment and bird type regarding their effect on time it took birds to resume calling. Urban birds tended to decrease their call rates more than rural birds following treatments, suggesting that urban birds, even when living in rural habitats, can better adapt to anthropogenic noise.

What inspired you to participate in undergraduate research?
I have always loved the outdoors and seek a greater understanding of how the natural world works and how humans impact this balance. I also hoped to increase my knowledge of the fieldwork component of Ecology.

How did you get your research position, and what preparation did you undertake for it?
I applied and got accepted to Notre Dame’s UNDERC East program. This program includes a ten-week field course open to both Notre Dame and non-Notre Dame students. I participated in a mandatory one-credit prep class the semester before attending this summer program, and I worked with a graduate student mentor to develop a project proposal so I was ready to begin upon arriving to UNDERC.

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

What did you get out of your research experience?
In addition to meeting a wonderful group of undergraduates, graduate students and professors in the field of Ecology, I gained a greater understanding of and appreciation for the scientific method from formulating questions and developing sampling techniques to problem solving in the field and analyzing data.
Heart disease is the leading cause of death in the United States and the entire world. Arrhythmias, or improper beating of the heart, can cause heart disease by damaging the heart’s electrical system. Currently the electrocardiogram (ECG), a painless test that records the heart’s electrical activity, is used to diagnose various heart conditions. However, electrocardiographic differentiation of different types of supraventricular arrhythmias can be very difficult. Therefore, the diagnosis of cardiac arrhythmias needs to be more accurate and less complicated. To address this issue, a more effective and precise method of diagnosing supraventricular arrhythmias was tested. Specifically, a large database of supraventricular arrhythmias was analyzed using a new method developed in-house called the Electrocardiomatrix (ECM). Key features of supraventricular arrhythmias were identified with the ECM, which allowed for accurate differentiation of types of supraventricular arrhythmias based on the new method. The ECM displays long periods of cardiac signals that capture every heartbeat in a compact manner. This new method is intuitive and allows for single-glance visualization of changes in heart rate and heartbeat structure. Ultimately, application of the ECM in clinical practice would allow for more speedy and accurate diagnosis of heart conditions such as supraventricular arrhythmias.

What inspired you to participate in undergraduate research?
As a pre-medical student, I became very interested in biomedical research because it is a great way to learn more about the field of medicine and it offers a way to directly help others by working to treat and prevent diseases.

How did you get your research position, and what preparation did you undertake for it?
After reading my research mentor’s papers, I became very interested in her research and applied to a summer research fellowship that allowed me to work in her lab. I prepared for the fellowship by reviewing all of the papers produced by the lab that I would be working in.

Where was your research experience located?
University of Michigan Medical School

What did you get out of your research experience?
Working in a research lab was a great learning opportunity. I obtained exposure to conducting research in a graduate research lab and gained experience in a career that I hope to pursue in the future.
A Scanning Tunneling Microscope (STM) is often used to explore and image the electronic structures and topographies of nearly two-dimensional surfaces. The STM has been used to explore the electronic structure of many crystalline surfaces, and such research is done quite regularly. Meanwhile, there exist materials called quasicrystals that exhibit properties somewhere between crystals, materials that exhibit translational symmetry, and glasses, which are unordered. The types of symmetry and order exhibited by quasicrystals are shared by Penrose tilings. As such, a Penrose tiling provides an interesting structure for study using the STM. Before such a study is conducted however, it is ideal to have an estimation of the results. This allows for any departures from theory to be easily recognized and a benchmark so that a problem during data collection can be identified. As such, simulations of the STM data were made that encompass the expected results given a tight binding model and a scattering model.

What inspired you to participate in undergraduate research?
I have always been interested in pursuing truth and understanding the way in which our universe operates. Undergraduate research gives an opportunity to gain a greater understanding of a certain research area. Along the way it aids in building human understanding on the whole. Thus, research is of benefit to me and others.

How did you get your research position, and what preparation did you undertake for it?
I had been working with Professor Gomes the previous semester. During which I made plans to continue my work over the summer in conjunction with the Notre Dame Physics REU.

Where was your research experience located?
University of Notre Dame

What did you get out of your research experience?
As mentioned research has helped me learn about new and exciting physics. Additionally, I learned more about myself as a researcher, as well as my interests in physics. I hope to be able to apply this knowledge to my work in the future.
Updated efforts using hemisphere-wide retrograde and anterograde tracing have provided large-scale static data about the architecture of the cortex. Previous studies of low-density interareal connectivity found emergent scale-free and rich club properties, however these may not apply to recent data. Recent macaque and mouse studies have reported high-density cortico-cortical wiring, and traditional methods fall short for the given density and directedness. Based on the Exponential Distance Rule framework proposed by members of this lab, we expected dense short-range connectivity with few long-range edges, resulting in a higher distribution of larger network cliques than would be found by chance alone. To test this, connection probabilities from the macaque and mouse data were used to build Erdős-Rényi graphs, thus modeling a randomly associating cortex as a null model. Analysis of the clique distribution of actual brains found core-periphery distinctions, implying underlying structure, whereas the model resulted in a characteristically random Gaussian distribution. Probing these models and datasets further with network science measures would offer insight on the communicational integrity of the brain, especially with regard to resilience to node or edge failures.

**What inspired you to participate in undergraduate research?**
I have always been intrigued by the question, “what makes us tick?” Having had a math and physics heavy upbringing, it seemed natural to do quantitative work, and the notion of neuroscience as the final frontier that’s just lying inside had me hooked.

**How did you get your research position, and what preparation did you undertake for it?**
I reached out to Prof. Toroczkai early on in my freshman year about his publications in *Neuron* on the network theory aspect of neuroscience. Over two or three meetings he detailed his work, and recommended papers and books to follow up with throughout my second semester. The summer after my freshman year I asked if I can get involved, and that fall I already had a project.

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

**What did you get out of your research experience?**
Undergraduate research has helped me see the difference between knowing the material and understanding it. I could have read the same papers, manuals, and websites that I have independently, but by being in group meetings I could ask for elaborations and then interact with it directly through my project, thus seeing the living side of science.
3D Crystal Engraving as a Medium for Visualization of X-Ray CT Data

Aislinn Betts
Major: Science-Business
Advisor: W. Matthew Leevy, Department of Biological Sciences, University of Notre Dame
Coauthors: Matthew McGoldrick, University of Notre Dame; W. Matthew Leevy, University of Notre Dame Department of Biological Sciences, Harper Cancer Research Institute, and In Vivo Imaging of ND Integrated Imaging Facility; Kody Organ, Models Plus; Michael Pokuta, Models Plus; and Jeff Maki, Models Plus

The invention of 3D imaging and printing has revolutionized how medical models can be produced and utilized. Precise anatomical structures of humans and other organisms can be made in little time. These structures can be held in the palm of the head and visualized in a whole new way. While models can be made from a 3D printer, they can also be constructed by burning 3D images into crystals. The files for these products are derived from CT scans and CT databases. Programs such as netfabb and Meshlab allow for the modification and repair of the structures. Finished files are sent to the company Models Plus, where a laser inscribes the 3D structure into a crystal. The first crystal successfully made was of a rabbit skull. Since then, a rat skeleton, a human skeleton, a human skeleton cut in half, a human skull, and a human foot have been engraved into crystals. Additional clinical data and CTs of other animals are in the process of being made. To conclude, 3D crystal engraving is an easy and inexpensive way to visualize CT scans of anatomical structures. Comparison of this technique with 3D printing reveals that 3D crystal engraving excels in its capability to produce models with higher resolution and more detailed structures. While the current crystals are fantastic learning tools, labeling of key parts within the crystal can optimize the educational value of these models.

What has inspired you to participate in undergraduate research?
My love for solving problems and interest in the medical community sparked my desire to get involved in research.

How did you get your research position, and what preparation did you undertake for it?
Since I wanted to get involved in research but was unsure how to do so, I attended the Center for Undergraduate Scholarly Engagement’s workshop, “Getting Started in Research.” It provided me with information on how to find available positions and what to include in emails to professors. When I came across Dr. Leevy’s work this summer, I emailed him expressing my interest in his research and inquired about a position in his lab. He emailed me back and we met up at the beginning of this semester.

Where was your research experience located?
University of Notre Dame

What did you get out of your research experience?
I have learned a great deal about the research process and how it is carried out. It has been neat learning about new technology and the ways it can benefit the medical field.
Osteosarcoma (OS) is the most common malignant bone tumor in pediatric patients, affecting 4-5 children per million each year. The survival rate for patients with OS has remained relatively unchanged for 30 years. Thus, there is a significant need for new therapeutic techniques to combat OS. One novel immunotherapeutic approach to increasing OS survival involves natural killer (NK) cells, a part of the innate immune system that do not require prior sensitization to recognize malignant cells. Previously, treatment with NK cells has been limited by poor ex vivo expansion. Canines spontaneously develop OS with high biological similarities to human OS. However, canine NK cells have yet to be identified. The identification of canine NK cells and the capability to expand them ex vivo would allow for the study of NK cell immunotherapy for OS in this valuable animal model with an intact immune system. Through flow cytometry, NK cell expansion, and cytotoxicity assays, canine NK cells were defined by their expression of NKp46 and lack of T-cell, B-cell, and macrophage lineage markers, expanded rapidly when co-cultured with K562 Cl.9.mbIL21 feeder cells, and killed canine OS and melanoma cell lines without prior sensitization.

**What inspired you to participate in undergraduate research?**
I’ve always been really interested in understanding some of the mechanisms behind how different processes work in the human body, regardless of the field of study. I really enjoy studying psychological processes in my undergraduate research lab at Notre Dame, and I was interested in conducting research in a different discipline to gauge my fascination with biological processes, particularly in cancer biology.

**How did you get your research position, and what preparation did you undertake for it?**
I obtained my research position after applying for the Joint University of Notre Dame-MD Anderson Cancer Center Summer Undergraduate Research Program through the University of Notre Dame College of Science. To prepare for it, I read articles from my mentor and asked friends who participated in the program last year about their experiences.

**Where was your research experience located?**
MD Anderson Cancer Center, The University of Texas, Houston, Texas

**What did you get out of your research experience?**
Through this program, I had an exciting summer in a new city, made new friends, experienced the largest medical center in the country, and learned a ton about osteosarcoma, animal models, immunotherapy, conducting bench research, and even about myself. I also learned how to prepare for and present at a lab meeting and a poster presentation.
A study of the developmental metabolome of *Xenopus laevis* by capillary electrophoresis-mass spectrometry

Danielle Boley
Major: Biochemistry
Advisor: Norman J. Dovichi, Dept. of Chemistry and Biochemistry, University of Notre Dame
Coauthors: Jennifer Arceo, Nicole Schiavone, Roza Wojcik, Scott Sarver, Elizabeth Peuchen

Metabolomic analyses provide an understanding of downstream effects of cellular pathways and play a role in identifying potential biomarkers but there is a need for improved analytical methods. We aim to perform capillary electrophoresis coupled to electrospray ionization-mass spectrometry (CE-ESI-MS) for metabolomics analysis of *Xenopus laevis* embryos in different stages of development. CE-ESI-MS is ideal for metabolomic analysis because it can separate and detect a wide variety of analytes while offering advantages in speed, efficiency, and limited sample consumption. We chose *Xenopus* because it is a traditional model system for studying the cell cycle and cell death and has recently been expanded to studying metabolic phenotypes present in tumor cells and spinal cord regeneration. Our preliminary results showed a clear increase in the number of features present as the *Xenopus* embryos matured and preferential ionization for some analytes in positive vs. negative ion mode. Future work will include imaging MS to generate ion maps of a cross-section of an embryo as a complement to CE-ESI-MS.

What inspired you to participate in undergraduate research?
“I would like to attend graduate school and become a scientist, so I chose to participate in undergraduate research to help me determine my research interests and gain skills that will benefit me in the future.”

How did you get your research position, and what preparation did you undertake for it?
“My summer research position was funded by the Glynn Family Honors Program. I had worked in the Dovichi lab since June 2014, so I had been trained on the instruments previously. To become more familiar with this project, I read all of the relevant journal articles I could find.”

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

What did you get out of your research experience?
“I became a more independent researcher because of my research experience. I believe it brought me another step closer to being prepared for graduate school.”
Investigating circadian control of Trypanosome brucei differentiation

Michael Broderick
Major: Neuroscience
Advisor: Filipa Rijo-Ferreira, Dept. of Neuroscience, U.T. Southwestern Medical Center
Coauthors: Filipa Rijo-Ferreira, Joseph S. Takahashi

Human African Trypanosomiasis (Sleeping Sickness) is a parasitic disease endemic to sub-Saharan Africa. Fatal if untreated, the disease affects both human and livestock populations. The parasite’s complicated life cycle requires a series of differentiations within the mammalian host and Tsetse fly vector. Based on previous research that has suggested the possibility of circadian rhythms within the parasite, our research focused on one differentiation stage, from slender to stumpy morphology within the mammalian host. The goal was to identify if the differentiation was controlled by quorum sensing processes or circadian mechanisms. This stage is important because it is required for future transmission of the parasite. This differentiation process was monitored via fluorescent quantification of stumpy specific protein PAD1. Using this method, stumpy population was examined over time. Results have shown that PAD1 expression oscillates throughout the day independent of changes in the total population density. Results also show quorum sensing control of the initiation of these oscillations, suggesting a mixed model between quorum and circadian control of the population of the stumpy morphology. Possible implications of these findings are transmission optimization via synchronization with vector activities or diametric opposition to immune fluctuations. Further directions of this research include chronotherapeutic experimentation.

What inspired you to participate in undergraduate research?
“I wanted to explore multiple career path options rather than just focus on being a pre-med and trying to find the answers to questions that no one else in the world knows is exciting.”

How did you get your research position, and what preparation did you undertake for it?
“After researching multiple summer research fellowships and applying, UT Southwestern offered the best benefits and opportunities for me to do impactful and interesting research in my field of interest. I made sure to email ahead before the school year was over and read up on what the current projects people in my lab were working on including my mentor’s.”

Where was your research experience located?
“University of Texas Southwestern Medical Center in Dallas, Texas”

What did you get out of your research experience?
“An exhilarating summer in Dallas, full of meeting new friends from around the USA and the world, hearing lectures from around the medical center, and finding out more about what my own interests are in the scientific theater. This experience shifted my interests to increasing my future participation in translational research.”
Trafficking of *Mycobacterium tuberculosis* protein HspX onto exosomes following its administration to C57B/6 mice

Barry Bryant  
Major: Science-Business  
Advisor: Jeffrey S. Schorey, Dept. of Biological Sciences, University of Notre Dame  
Coauthors: Victoria L. Smith, Dept. of Biological Sciences, University of Notre Dame

*Mycobacterium tuberculosis* (*M.tb*) is estimated to have caused more deaths than any other microbial pathogen in history and results in nearly 2 million deaths each year. Research in the lab has demonstrated that *M.tb* proteins are expressed on exosomes. Exosomes are small 30-100 nm extracellular vesicles of endocytic origin that are composed of a lipid bilayer and have been shown to function in intracellular communication and the modulation of a host immune response. Exosomes, having been found to have both immunogenic and adjuvant properties, along with their ability to present mycobacterial antigens and co-stimulatory molecules on their lipid surface, are being studied for their potential use as vaccines for diseases such as *M.tb*. We have shown, in *vitro*, that ubiquitination is necessary for the *M.tb* protein HspX to be trafficked onto exosomes. We hypothesized that ubiquitination is also necessary for the *M.tb* protein HspX to be trafficked onto exosomes in *vivo*. To test this, we administered purified wild type protein and a mutant lacking a ubiquitination site into C57B/6 mice via intratracheal injection. Preliminary evidence from exosomes harvested from bronchial lavage fluid suggests that ubiquitination is necessary for trafficking of HspX in an *in vivo* model.

**What inspired you to participate in undergraduate research?**

“I love pursuing truth, and what better place to do so than in the biological sciences. The opportunity to make contributions that will ameliorate suffering is seductive.”

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

“Based on my performance in his class and demonstrated interest in the subject matter, Dr. Schorey recruited me to join the Schorey Lab. I became a member in January of 2015 and was thoroughly prepared for this position by the rigors of biology courses and labs at Notre Dame.”

**Where was your research experience located?**

“The University of Notre Dame du Lac”

**What did you get out of your research experience?**

“I have gained countless friends and mentors through my research experience here at Notre Dame. I have improved my scientific writing and sharpened my analytical skills through the design and execution of novel experiments.”
Interest in marine metabolites exploded after several of the compounds demonstrated cytotoxic and antiviral properties. Since then, more than 10,000 such metabolites have been identified, including a family of cyclic pseudo-peptides isolated from the Prochloron symbiote of the sea squirt *Lissoclinum patella*. Though their exact metabolic role remains unclear, due to the high concentration of Cu$^{2+}$ found in *L. patella* (10$^4$ compared to the surrounding sea water) it has been suggested that they may participate in Cu$^{2+}$ storage or transport, detoxification, or in the catalysis of hydrolase activity by dinuclear copper(II)-patellamide complexes. It has been demonstrated that dinuclear copper(II)-patellamide complexes exhibit enzyme like activity over a wide pH range. While phosphatase activity has an optimal pH of 7-8, glycosidase like activity has been observed at pH 9-10. It could not be determined whether the active complex present at lower pH values also assists in the cleavage of glycosidic bonds because the 4-nitrophenolate produced by the substrate used to observe the hydrolysis of glycosidic bonds (4-nitrophenyl-D-glucopyranoside) is protonated after cleavage at a pH below 7.4, rendering measurements below that point useless. Subsequently, a glycosidase substrate which remains deprotonated at lower pH values, 2,4-dinitrophenyl-D-glucopyranoside, was synthesized.

**What inspired you to participate in undergraduate research?**
“The opportunity to finally apply the concepts I had been learning about in classes for years.”

**How did you get your research position, and what preparation did you undertake for it?**
“I was discussing summer research with my research mentor here, and asked me if I would be interested in an exchange opportunity in Germany. I prepared primarily by familiarizing myself with the lab group’s research area and reading some of the recent literature published by the group.”

**Where was your research experience located?**
“Ruprecht-Karls-Universität Heidelberg in Heidelberg, Germany”

**What did you get out of your research experience?**
“Outside of the obvious benefits from being able to work and travel in Germany for two months, I gained invaluable experience and confidence in lab as well as a better understanding of what I want to do with my future in chemistry.”
Working with FPGA Emulation Code for the CMS Upgrade

John Charters and Kaitlin Salyer

Major: Physics

Advisors: Kevin Lannon and Mike Hildreth, Dept. of Physics, University of Notre Dame

Within the next decade, the Large Hadron Collider (LHC) will be upgraded to the High Luminosity LHC (HL-LHC). The upgrades will increase the number of particles in the accelerator in order to produce rarer collisions. The Compact Muon Solenoid (CMS) will require an enhanced trigger system to manage all of these interactions and determine which events to save. We are primarily trying to apply the tracking detector algorithms to the Level 1 Trigger. Our research project relied on event simulations using a Field-Programmable Gate Array (FPGA) Emulation code written by a team of physicists. Most of our research involved evaluating the effectiveness of a tracking algorithm in correctly identifying particle tracks, provided data from muon samples. By comparing the track parameter variables with track stubs in different seeding layers, we obtained insight into how the algorithm generates the tracks. Our other studies involved answering a series of questions about the geometry of the detector and which seeding layers were best at reconstructing tracks. Our results continue to be used by the code developers in order to optimize the design of the FPGA chips, which will be installed in the near future.

What inspired you to participate in undergraduate research?
We were both interested in particle physics and wanted to get involved in the high-energy physics group. Basically we like physics a little too much.

How did you get your research position, and what preparation did you undertake for it?
We both expressed an early interest in working with Kevin Lannon, our physics professor last year. He taught an elective research class along with Mike Hildreth, which we took last spring. This opened the door for us to continue working under them during the summer and into this school year.

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

What did you get out of your research experience?
We not only learned valuable coding and analytical skills, but also earned a better understanding of academic careers in physics. We were required to give presentations every other week to update physics professors from across the country on our progress, which improved our communication skills and allowed us to personally contribute to a large-scale project.
**Using mercury to assess stocking with Atlantic Salmon (Salmo salar) as an alternative to Pacific salmon (Oncorynchus spp.) in the Upper Great Lakes**

Sean Cullen  
Major: Environmental Sciences  
Advisor: Dominic Chaloner, Dept. of Biological Sciences, University of Notre Dame  
Coauthors: Brandon Gerig and Gary Lamberti

Pacific salmon (*Oncorynchus* spp.) and Atlantic salmon (*Salmo salar*) are piscivorous non-native salmonids in the Great Lakes. Pacific salmon have been stocked for several decades but recent declines have compelled state agencies to consider alternatives such as Atlantic salmon. In the Great Lakes, contaminants such as mercury (Hg) accumulate via biomagnification as they pass up food webs, with rates of bioaccumulation potentially reflecting life history, morphology, diet, and rearing location. Mercury is of concern because aerial deposition is increasing while upper trophic level fish can accumulate potentially dangerous concentrations, for both fish and consumers. We determined which factors influenced mercury levels in Chinook (*O. tshawytscha*), coho (*O. kisutch*), and Atlantic salmon sampled from Lakes Huron, Michigan, and Superior. Species identity was an important factor in concentration levels (ANOVA, p<0.001), with Chinook salmon being the most contaminated (242.15 ± 8.20 ppb), followed by coho (139.48 ± 8.15 ppb) and Atlantic (99.72 ± 6.80 ppb). Fish size was a significant predictor of Hg (Linear Models), whereas capture location was not (ANOVA, p=0.130). This research suggests that Atlantic salmon could be considered as a replacement for Pacific salmon if lower contaminant burdens are the goal for human and environmental safety.

What inspired you to participate in undergraduate research?

I wanted to experience real research, and to work and learn in a lab setting without being told exactly what I needed to do. I was interested in answering questions that I asked, rather than those asked by others.

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

I began helping in the Lamberti Lab in the fall of 2014, helping graduate student Brandon Gerig with his research. With the help of him and Dominic Chaloner, I designed my own independent research project set to begin in the summer of 2015. I met with them on a weekly basis to prepare.

Where was your research experience located?

University of Notre Dame

What did you get out of your research experience?

I gained a lot of insight into real research and what goes into graduate work, as well as how professional scientists do their job. I learned how to think critically in a research setting to answer questions and solve problems in order to further my research goals.
Pancreatic adenocarcinoma (PDAC) generally presents as an advanced, unresectable malignancy due to nonspecific symptoms and the lack of clinically practical screening methods. Recently, there has been a push to develop a liquid biopsy for the early detection of PDAC that will allow noninvasive diagnosis through blood sampling. Exosomes, 50-150nm membrane-bound vesicles of endocytic origin, are a candidate biomarker for PDAC in the blood. In this study, exosomes isolated from the conditioned media of normal and neoplastic cell lines as well as from the plasma of PDAC patients and healthy individuals were physically characterized in an attempt to identify a cancer-associated exosome signature. Using the Particle Metrix single particle tracking analyzer, exosome size, yield, and particle kinetics data was collected. Exosomes isolated from PDAC tumor cells and from PDAC patient plasma were larger on average compared to controls. However, exosome counts were not correlated with disease status. Exploratory analysis of a subset of PDAC cases suggested that the particle kinetics of circulating exosomes might be useful to distinguish PDAC patients from healthy individuals. Continued development of a systematic basis for evaluating the physical attributes of patient-derived exosomes may lead to a non-invasive screening method for localized PDAC, allowing early diagnosis, prompt intervention, and increased survival rates.

What inspired you to participate in undergraduate research?
I was motivated to get involved in undergraduate research to explore biomedical research as a possible career path. I also hoped to take advantage of the opportunity to contribute to cutting-edge research that truly has the potential to improve healthcare outcomes.

How did you get your research position, and what preparation did you undertake for it?
I applied for the University of Notre Dame-MD Anderson Joint Summer Undergraduate Research Program, which gives a group of Notre Dame students the opportunity to do cancer research in Houston’s incredible Texas Medical Center. Once I received the name of my mentor, I read his recent publications to familiarize myself with his work.

Where was your research experience located?
The University of Texas MD Anderson Cancer Center

What did you get out of your research experience?
Throughout my ten-week program I gained a realistic perspective on careers in biomedical research, knowledge about cancer biology and novel research approaches, as well as technical, data analysis, and professional skills. I also was able to shadow an MD Anderson physician, explore a new city, and become friends with fellow undergraduate research interns from Notre Dame and other universities.
Modafinil and Caffeine for treatment of coma and unresponsiveness associated with edema of the reticular activating system (RAS) in a pediatric patient

Michael DiGaetano  
Major: Science-Business  
Advisor: Catherine Anne Mazzola, New Jersey Pediatric Neuroscience Institute

Modafinil is a dopamine re-uptake blocker that incites wakefulness via the central nervous system (CNS). It has been approved by the United States Food and Drug Administration (FDA) for the treatment of narcolepsy and has been used post-operatively to treat disorders of wakefulness causing lethargy. Although modafinil is not approved by the FDA for children, it has been used clinically and reported in various pediatric studies. Modafinil has been used in clinical studies for children with Attention Deficit Hyperactivity Disorder (ADHD) and narcolepsy. This presentation illustrates the case of an 11-year-old child that underwent a resection of a brain stem tumor. Post-operatively, the patient did not wake up and post-operative somato-sensory evoked potentials (SSEP’s), motor evoked potentials, cranial nerve testing, and brain stem auditory evoked responses (BAER’s) were repeated found to be normal. Electroencephalography (EEG) showed delta and theta waves. Magnetic resonance imaging did not show any definite hemorrhage or ischemia. There was edema noted in the posterior mesencephalon and caudal hypothalamus. Modafinil was started in an attempt to stimulate the reticular activating system. Within 48 hours, the patient began following commands. The patient continues to be awake and alert now, several months after surgery.

What inspired you to participate in undergraduate research?
I wanted to see research from a clinical perspective rather than a laboratory perspective, which I had experienced in the previous semesters. Also, the topic of this case study/research was very interesting to me such that when I heard about the case, I quickly began researching the topic and devouring related publications.

How did you get your research position, and what preparation did you undertake for it?
I applied for a summer internship at the New Jersey Pediatric Neuroscience Institute and part of the internship was to engage in a few aspects of clinical research. One of the suggested recommendations for applying was previous exposure to neurosurgery and have an interest in neuroscience. The preparation for the internship was completion of a HIPPA packet similar to that of a volunteer in a hospital.

Where was your research experience located?
New Jersey Pediatric Neuroscience Institute

What did you get out of your research experience?
I have forged great mentor-student relationships with the neurosurgeons at the practice and have learned a lot about the field of neurosurgery. Such learning includes but is not limited common diagnoses, how to write a proper “note” for records, and impact and nerve testing while also developing a familiarity with the process of publishing in scientific journals. It has also piqued my interest in applying to an MD/PhD program rather than an MD program.
Cardiovascular diseases are the leading causes of death globally. We have previously found that mice with smooth muscle cell (SMC)-specific deletion of the mineralocorticoid receptor (MR-KO) lack the aging-associated rise in cardiac hypertrophy and fibrosis. We hypothesize that SMC-MR contributes to cardiac gene expression alterations with aging that contribute to cardiac hypertrophy and fibrosis and to the predisposition of the heart to atrial fibrillation (AF) with age. The first aim was to characterize alterations in cardiac gene expression with aging in mice. Left ventricle tissue was isolated from SMC-MR knockout and MR-intact littermates. RNA was extracted and reverse transcribed before gene expression was analyzed by q/RT-PCR. In aim two we explore the role of SMC-MR in cardiac dysfunction and atrial fibrillation in aged mice. Cardiac ultrasound was performed on 19 month old SMC-MR knockout and MR-intact littermates. Using a novel electrophysiology protocol in which we induced atrial fibrillation, we compared the ability to induce atrial fibrillation in aged SMC-MR knockout and MR-intact littermate controls to determine if SMC-MR plays a role in aging-associated atrial fibrillation. These experiments have aided in the elucidation of the role of SMC-MR in cardiac gene expression and investigated the role of SMC-MR in atrial fibrillation.

What inspired you to participate in undergraduate research?
“I have been trying to decide the best career path for me and this opportunity provided experience working by myself in a lab environment, 40 hours a week. I also enjoy the intersection between translational medicine and genetics.”

How did you get your research position, and what preparation did you undertake for it?
“I was searching online for various summer research programs when I came across this one in Boston, a city I have always wanted to visit. I also had the opportunity to do research in a field that I thought was very interesting in the medical center, which was a great environment. I did not need to do any preparation for this summer’s research other than reading some papers my PI sent to me to read.”

Where was your research experience located?
“Tufts Medical Center/Tufts University Sackler School of Graduate Biomedical Sciences”

What did you get out of your research experience?
“I got to make friends with many great people from schools across the country and internationally as well. It also helped me to decide what career path I want to take in the future. Lastly, I got to experience the summer time in Boston, which is awesome. I can’t wait to return.”
The Role of Casein Kinase 1 and GLI2 Inhibition on Smo-ablated Carcinoma-Associated Fibroblasts

Shourik Dutta
Major: Biochemistry
Advisor: Michael Ostrowski, Dept. of Molecular and Cellular Biochemistry,
The Ohio State University

Smoothened (SMO), a gene producing G-protein coupled receptors active in the developmental Hedgehog (HH) pathway, is suspected of contributing to the progression of pancreatic ductal adenocarcinoma (PDAC). The interplay between Smo-deletion and downstream molecular effects on proteomic actors is not clearly understood. To enhance understanding of how Smo-deletion confers increased malignancy and poorer clinical outcomes, several in vitro studies were conducted on Smo-ablated stromal fibroblasts from a Kras-initiated tumorigenic model. Here, we focus on two key downstream interactions involved in Smo-deletion. First, SMO has been linked to stabilization of PTEN, a tumor suppressor whose expression positively correlates with patient survival. Previous studies show PTEN is destabilized by ubiquitin E2 conjugating enzyme (UBE2K) within Smo-deleted fibroblasts. Inhibition of casein kinase 1 (CK1), a candidate phosphorylating agent of UBE2K, destabilized UBE2K and stabilized PTEN levels in a dose-dependent manner. Second, we examine the connection of Smo-deletion to the oncogenic PI3K-AKT pathway. PI3K-AKT pathway is implicated in the progression of tumors in PDAC, but its role in stomal fibroblasts is unclear. Microarray analysis of Smo-ablated fibroblasts shows high upregulation of Gli2 (a target protein in the HH pathway) and Tgfa (a growth factor connected to the PI3K-AKT pathway). To determine the interaction between these bridging actors, a transient siRNA knock down of Gli2 was conducted and caused a substantial decrease of Tgfa. This study demonstrates not only the connection between SMO-PTEN and PI3K-AKT pathways, but an elucidation of tumor-microenvironment interaction in PDAC progression that can be utilized to develop candidate therapeutics.

What inspired you to participate in undergraduate research?
“Due to my career interest in pursuing an M.D., I wanted to gain some experience on what it was like to work in a lab environment on translational research, since it plays an instrumental part of advancing patient therapeutics. I am driven to study cancer, particularly breast and pancreatic cancer, due to the prevalence, poor survival rates, and complexity of these diseases.”

How did you get your research position, and what preparation did you undertake for it?
“I applied to the OSU SUCCESS Program, a 10 week M.D./Ph.D. fellowship, and was accepted. The program was a combination of bench research at a lab we were matched with and career development seminars that augmented the experience. Before applying, I made sure to thoroughly go through my application to make sure my personal statement and application responses were clear and showed my abilities as an applicant. This took a fair amount of introspection and research about the program and its values.”

Where was your research experience located?
“The Ohio State University”

What did you get out of your research experience?
“An immense amount of knowledge about the difference between the career paths of M.D. and M.D./Ph.D. and the time, effort, and persistence it takes to make meaningful strides in the scientific community. I learned how to properly write up and present an independent project, what considerations go into the publication of a paper, and how to build an effective relationship with a mentor.”
Caribbean reefs need *Acropora cervicornis* due to its reef-building abilities and high propagation rate to restore reef biodiversity; however, most of the *Acropora cervicornis* population was reduced due to bleaching events and white band disease. In order to restore these colonies in the Little Cayman reefs, the Central Caribbean Marine Institute (CCMI) started a nursery program where new coral is outplanted to the reefs. *A. cervicornis* out-plant sites were selected based on the origin to the parent colony, bottom type, water quality, wave exposure, amount of traffic, algae content, and sedimentation. At each outplant site, a variety of five *A. cervicornis* genotypes were attached to the reef. Outplant survivorship in Little Cayman from 2013 to 2015 was 67%, comparable to other successful Caribbean nurseries. One of the five genotypes had statistically significant increase in total linear extension (TLE), suggesting an adaption to promote faster growth. Depth did not have a significant effect on TLE growth suggesting these five genotypes can be outplanted at any depth. Because the CCMI nursery program has only recently developed, sample sizes need to be increased before any definitive conclusions can be drawn.

**What inspired you to participate in undergraduate research?**
I’ve always loved working hands-on both in lab and in the field. Not only that, but I’ve always had a soft spot for coral. This opportunity gave me the opportunity to combine my love of coral reefs and research.

**How did you get your research position, and what preparation did you undertake for it?**
I found out about this internship in an e-mail sent to the College of Science students. To prepare for this position, I had to submit an application and attend an orientation after acceptance into the program.

**Where was your research experience located?**
The Central Caribbean Marine Institute on Little Cayman

**What did you get out of your research experience?**
My research experience expanded my networking horizons. I not only made connections to experts in the field of marine biology, but also with lifelong friends and, hopefully, future colleagues. I learned how to identify the different species of coral and fish in the Caribbean while working on research proposals and refining my poster-making skills.
**iLocater: A Diffraction-Limited, Radial Velocity Planet Finder**

Michael Foley  
Major: Physics, Honors Mathematics  
Advisor: Justin Crepp, Dept. of Physics, University of Notre Dame  
Coauthors: David Shaw, Elliott Runburg, Andrew Bechter, Jonathan Crass, Ryan Ketterer, Justin R. Crepp, David King, Bo Zhao, Robert Reynolds, Philip Hinz, Jack Brooks, Eric Bechter

Existing RV spectrographs are subject to systematic errors arising from their seeing-limited design, especially from modal noise in large, multi-mode fibers. To address this, we present the development of iLocater, an ultra-precise single-mode fiber-fed spectrograph operating at the diffraction limit to be installed at the Large Binocular Telescope (LBT). The unprecedented degree of precision offered by iLocater will lend itself to numerous astronomical studies, including the study of planetary formation in close binary systems and the characterization of super-earth atmospheres.

We present the design for the iLocater demonstration system, slated for on-sky testing in Spring 2016. In particular, this poster shall elaborate on the development of instrument control software and simulations for iLocater. Using Matlab, we implemented novel control algorithms to achieve movement precision on the nanometer scale and fiber-coupling efficiency in the lab within 5% of the theoretical maximum. Further, we developed a robust computer simulation of iLocater and incident stellar spectra to test the data reduction pipeline and the suitability of an H4RG detector for our purposes. Finally, we utilized INDI, a server-based library that specializes in device driver creation and user-instrument communication, to develop software for long-range remote control of the device.

**What inspired you to participate in undergraduate research?**  
“We are fascinated by the potential to explore more of our universe and discover an earth-like planet. As such, we couldn’t turn down an opportunity to work with Professor Crepp on such a revolutionary device.”

**How did you get your research position, and what preparation did you undertake for it?**  
“We all had worked with Professor Crepp for at least a year and developed strong interests in the software components of his iLocater project before embarking on our summer experience. After completing academic-year research on our respective projects, we all were awarded grants from Notre Dame College of Science and the Department of Physics to fund our summer research.”

**Where was your research experience located?**  
“University of Notre Dame”

**What did you get out of your research experience?**  
“New friends, professional relationships, and intensive experience in coding. Further, we became well-versed in the scientific process and laboratory work, knowledge that will inevitably benefit us as we pursue graduate studies.”
Pterois volitans, lionfish, are an invasive species posing serious threats to Caribbean coral reefs because of their immense appetites, few predators, and consumption of many herbivores. The current study examined the diet of lionfish on the reefs of Little Cayman over a 4 year time period. Lionfish were collected with nets and spears off Little Cayman from August 2011 through May 2015 at dusk. Lionfish stomachs were removed and contents were identified to the lowest possible taxa. Of the stomachs, 70% contained food, consisting of 70% vertebrates, 26% invertebrates, and 4% other. Diet type did not display a seasonal trend; however, empty stomachs increased in the summer. The lionfish breeding season peaks in March, April, and August, so lionfish may eat more in the winter and spring to prepare for mating. As the vast appetite of lionfish is costly to coral reef community dynamics, the need for more efficient culls is essential for the regulation of lionfish populations.

What inspired you to participate in undergraduate research?
I learn best via experience, so I wanted to partake in some hands on learning.

How did you get your research position, and what preparation did you undertake for it?
My research was part of a summer study abroad program via Rutgers University. To prepare for my research I read many of the Central Caribbean Marine Institute’s published papers and learned the fish, coral, and algae species of the Caribbean.

Where was your research experience located?
Little Cayman Research Centre, Little Cayman, Cayman Islands

What did you get out of your research experience?
I studied abroad and explored an area of study, marine biology that is not extremely prevalent at Notre Dame. Additionally, I had the opportunity to scuba dive along the beautiful Caymanian coral reefs.
Evaluation of MMP-13 Selective Inhibitors: Possible Osteoarthritis Treatments

Emma Frost
Major: Biochemistry
Advisors: Shahriar Mobashery and Mayland Chang, Dept. of Chemistry and Biochemistry, University of Notre Dame
Coauthors: Ming Gao, Maria Bastian, Elena Lastochkin, Valerie Schroeder, William Wolter, and Mark A. Suckow

Osteoarthritis is the most common joint disease in the world. Current treatments largely focus on symptom management rather than the disease’s etiology. Matrix metalloproteinase-13 (MMP-13) is known to play a role in metabolism of bones, and therefore its inhibition may be targeted for effective treatment of osteoarthritis. Nineteen compounds were designed, synthesized and evaluated for inhibition of MMP-13 and the closely related MMP-8, as well as other MMPs. Seven compounds inhibited MMP-13 by >50% at a concentration of 10 µM. Two compounds, MB050 and MB071, were potent and selective inhibitors of MMP-13, with $K_i$ values of 40 ± 10 nM and 190 ± 10 nM, respectively, and 200- and 35-fold selectivity towards MMP-13. The compounds had low in vitro toxicity but relatively low solubility. A pharmacokinetics study in mice showed that MB050 had low clearance, a high volume of distribution, and a terminal half-life of 5.3 hr. Thus, MB050 shows potential as a therapeutic in diseases where MMP-13 is upregulated, such as osteoarthritis.

What inspired you to participate in undergraduate research?
“I really enjoyed the hands-on experience of class labs and was intrigued by seeing drug development in its very early stages.”

How did you get your research position, and what preparation did you undertake for it?
“I have been a part of Dr. Chang and Dr. Mobashery’s lab since August 2014, after reading some of Dr. Mobashery’s papers and approaching him about possibly becoming a member of his lab. I participated in the course Introduction to Undergraduate Research in my freshman spring to gain lab experience prior to joining, and a grant from the Glynn Family Honors Program this past summer allowed me to complete extra training to make this year more productive.”

Where was your research experience located?
“University of Notre Dame”

What did you get out of your research experience?
“I’ve learned so much since the beginning, and I even feel more prepared in my coursework because of the topics in which I’ve had hands-on experience. We’re working on submitting a paper, and I definitely think this whole project has made me a more confident undergraduate in the sciences.”
Isoflurane-Induced Neurotoxicity and Neuroinflammation in a Neonatal Piglet Model

Emily Geyer
Major: Neuroscience
Advisor: Emmett Whitaker, Dept. of Anesthesiology, The Ohio State University
Coauthor: Tanner Koppert

Every year, millions of children receive general anesthesia, and isoflurane is a commonly used inhaled anesthetic. While anesthetics have generally been accepted as safe, recent animal studies demonstrate anesthesia-induced neurocognitive deficits, calling the safety of anesthesia into question. While these animal studies are informative, they are lacking in clinical relevance and the details of the molecular pathways through which anesthesia is neurotoxic remain unclear. The aims of this study are to develop a clinically translatable animal model of anesthesia and to demonstrate the molecular inflammatory pathways caused by isoflurane in the brain. Because piglets have sophisticated, gyrencephalic brains, they are ideal models for neonatal anesthesia neurotoxicity screening. In analyzing the effects of anesthesia on piglet brains, both aims can be met. Piglets are assigned to one of three groups: control (no intervention), lipopolysaccharide (positive inflammatory control), and 2% isoflurane treatment (intervention). Blood and CSF are collected and brains are harvested upon treatment. Blood and CSF are analyzed for inflammatory biomarkers and brain tissue is analyzed using Western blotting, histopathology, and immunohistochemistry. It was hypothesized that isoflurane exposure results in significant cell loss. Early results indicate no significant difference in S100β (brain injury marker) and an increase in progenitor glial cells in isoflurane-treated piglets. Further studies are needed to elucidate the pathways of these results.

What inspired you to participate in undergraduate research?
I wanted to live at home for the summer, so I considered different options that would allow me to live in Columbus. I never thought I would be interested in doing research, but when a family friend put me in contact with a doctor doing research at Ohio State, I considered it a more real possibility. After meeting Dr. Whitaker and hearing about the cutting-edge research he was conducting, I decided it would be a great experience.

How did you get your research position, and what preparation did you undertake for it?
I reached out to Dr. Whitaker after a family friend that works with him informed me that Dr. Whitaker conducted research. I emailed Dr. Whitaker expressing an interest in his research and he said he was willing to take on an undergraduate assistant. My laboratory courses at Notre Dame helped prepare me for the bench portion of research, but I constantly read literature on the topics we were researching throughout the summer to stay informed on what was most current in the field.

Where was your research experience located?
The Ohio State University and Nationwide Children’s Hospital (Columbus, Ohio)

What did you get out of your research experience?
In addition to learning many common laboratory techniques, my research experience helped me learned the importance of collaboration when working with a team in a lab. I realized that I am interested in incorporating research into my long-term career goals, which is something to keep in mind as I decide what I want to do after Notre Dame. The relationships I established at Ohio State and Children’s Hospital ones I can maintain and utilize in my future endeavors.
Examination of Frontal Alpha Power in Pediatric OCD During a Visual Task

Rosie Giglia
Major: Neuroscience and Behavior
Advisor: Elana Harris, Dept. of Psychiatry and Behavioral Neuroscience,
University of Cincinnati
Coauthors: Kimberly Leiken, PhD, Nat Hemasilpin, PhD, Jing Xiang, MD, PhD, Paul Horn, PhD, Elana Harris, MD,PhD

Obsessive-Compulsive Disorder (OCD) is a neuropsychiatric disorder often beginning in childhood that is characterized by repetitive thoughts or images and ritualistic behaviors. Magnetoencephalography (MEG) has been used to study OCD in an adult population, but MEG studies of OCD in children are lacking. Data suggest that adults with OCD may display altered frontal alpha patterns to visual stimuli and that alpha power patterns may predict treatment responsiveness. To assess whether alpha power asymmetries exist in a pediatric population, neutral and symptom-provocative images for contamination-related OCD were presented in a RSVP block paradigm to 7 healthy children and 7 children with contamination-related OCD during recording with a 275-channel MEG system. Only neutral images were analyzed in this study. Peak and mean alpha responses to each picture were recorded for each subject. Analysis showed that peak frontal alpha power was asymmetric (R>L) in the healthy group and symmetric in the group with OCD. Mean frontal alpha power was symmetric in both groups. This study suggests that children with OCD and their healthy peers may process neutral images in a similar way, implying that OCD symptoms may be affected by state, rather than trait, differences in brain responses.

What inspired you to participate in undergraduate research?
I did a project using EEG through the same program last summer and enjoyed seeing the application of the imaging tools I had learned about in class. Getting to work with kids was also a lot of fun!

How did you get your research position, and what preparation did you undertake for it?
I got the position by contacting potential mentors and applying to the University of Cincinnati/Cincinnati Children’s Hospital Medical Center SURF program.

Where was your research experience located?
Cincinnati Children’s Hospital Medical Center

What did you get out of your research experience?
I learned how to analyze MEG data, practiced research and writing skills, and shadowed my mentor and other pediatric psychiatrists in outpatient and inpatient settings.
Testing a 160 Kinase Knockout Lentiviral CRISPR/Cas9 Library in an AT/RT Cell Line

Meredith Hollender
Major: Neuroscience and Behavior
Minor: Poverty Studies
Advisor: Simone Treiger Sredni, MD, PhD, Stanley Manne Research Institute

Atypical Teratoid Rhabdoid Tumors (AT/RT) are highly aggressive tumors of the brain characterized by genetic loss of SMARCB1, a component of the SWI/SNF chromatin-remodeling complex. Most patients are less then three years old at diagnosis, and no effective treatment is currently available. A kinase is an enzyme that phosphorylates molecules, resulting in changes to their activity, and is also often implicated in cancer. Kinase-inhibitors are common treatments for cancers. Thus, there is a potential for kinases as therapeutic targets in AT/RT. The RNA-guided CRISPR/Cas9 system can be programmed to induce DNA double-strand breaks at specific genomic loci. Using the CRISPR/Cas9 lentiviral delivery system, 160 different kinases were targeted and effectively knocked-out in an AT/RT cell line, resulting in 160 different cell lines. Experiments were performed in two stages of about 80 kinase-knockouts each. A Genomic Cleavage Detection assay confirmed effective knock-out of the targeted kinase. MTT assays, apoptosis assays, abnormal morphologies, and proliferation assessments were analyzed for each cell line. Preliminary results indicate the proto-oncogene B-RAF is implicated in AT/RT. B-RAF mutations have previously been associated with malignant melanomas, a particularly lethal and aggressive form of cancer. Further testing is needed to conclude B-RAF as a therapeutic target for AT/RTs.

What inspired you to participate in undergraduate research?
As a neuroscience major, my two biggest career options are the medical or the research path. This opportunity gave me intensive and interesting research experience that I could conduct near home.

How did you get your research position, and what preparation did you undertake for it?
I wanted to do research at an Institution associated with a hospital in Chicago, so that I could have some shadowing opportunities at the hospital, and so that I was near home. I began researching different labs in Chicago and emailed a bunch of research institutes with my interest and resume. Many were very receptive to my email, and loved the idea of an undergraduate coming in for the summer, especially from an elite university like Notre Dame.

Where was your research experience located?
Stanley Manne Research Institute in Chicago, IL

What did you get out of your research experience?
I have been able to apply the knowledge I gained to both my Cell Biology class and the Introductory Biology class that I TA for. It has made those opportunities much easier. I also learned many professional skills that revolve around communicating, networking, etc. And it was fun!
Glabrous Skin Cooling in Personal Protective Suit Attenuates the Rise in Core Body Temperature in Hot Environment

Adam Holmes
Major: Science Preprofessional
Advisor: Vinh Cao, Dept. of Biology, Stanford University

Use of personal protective equipment (PPE) suits in hot environments leads to an accelerated rise in core body temperature and consequently deleterious physiological effects in humans. Specialized vascular networks known as arteriovenous anastomoses (AVAs) underlie glabrous skin regions and serve as mammalian heat radiators by shunting large volumes of blood near the periphery. Cooling these glabrous regions of the face, feet, and palms significantly attenuates rise of core body temperature in individuals situated in hot environments as compared to cooling non-glabrous regions. The present study investigates the effects on core body temperature and heart rate when cooling glabrous skin of humans wearing PPE suits in a hot environment.

Consenting adults wearing a PPE suit sitting at rest in a 42°C environment were subjected to 3 conditions: constant cooling of the palms alone, constant cooling of palms and feet, and no cooling. Esophageal temperature and heart rate were monitored for the duration of each trial (approximately 65 minutes). Palm cooling reduced Esophageal temperature rise by 45%, whereas palm and foot cooling reduced rise by 77%. Reduction in heart rate was greater in foot and palm cooling conditions compared to palm cooling alone (53% vs 39%, respectively). The study is still in progress; therefore, no conclusions can be made.

What inspired you to participate in undergraduate research?
I’ve always had an innate curiosity in the natural sciences. Undergraduate research seemed to be a great way for me to put that curiosity to good use.

How did you get your research position, and what preparation did you undertake for it?
I found the physiology section of General Bio B to be very interesting. I spoke with my professor, Dr. John Duman, several times about getting involved in a human physiology research lab. When Dr. Duman taught the unit on thermoregulation, he mentioned the invention of a hand-cooling device that maximizes heat extraction from the palm of the hand and its remarkable effects on human performance. I began to find mammalian thermoregulation to be a fascinating topic due to temperature’s global effects that span from the macroscopic, behavioral level all the way down to the microscopic, molecular level. As it turns out, one of the co-inventors of the device, Dr. Craig Heller, is a colleague of Dr. Duman. It seemed like a perfect fit for me, and Dr. Duman put me in touch with Dr. Heller. I sent him my transcript, CV, and a letter of interest, and he accepted me into his lab. At the completion of the summer, I was invited to return to work in the lab during my gap year before medical school.

Where was your research experience located?
Stanford University

What did you get out of your research experience?
I think the experience helped me develop patience, critical thinking, and problem solving when engaging in scientific matters. I learned how to conduct interdisciplinary research, present scientific findings, ask interesting questions, and anticipate pitfalls in an experimental design. In addition, living in a new part of the country away from friends and family helped me grow as an individual. This fall I brought a hand-cooling device with me from the lab and am currently collaborating with the Director of Sports Science at Notre Dame on how to implement the technology in various varsity sports on campus. This allowed me to see the full translational spectrum of research, from bench to bedside, and the impact research can have on everyday life.
PKCε Membrane Binding in Response to Hypoxia

Evelyn Huang
Major: Science-Business
Advisors: Kenneth Olson, Indiana University School of Medicine-South Bend and Robert Stahelin, Indiana University School of Medicine-South Bend
Graduate Student Advisor: Eric DeLeon

Oxygen (O\textsubscript{2}) is crucial to vertebrate survival. For this reason, vertebrates contain oxygen “sensing” cells that monitor environmental oxygen availability and delivery to tissues. However, there are many conflicting theories of how changes in oxygen partial pressure (pO\textsubscript{2}) are transduced into a physiological response. Research has shown H\textsubscript{2}S-oxygen sensing mechanisms in vessels of all vertebrate classes, and various kinds of cells. For example, all cells produce H\textsubscript{2}S, and compounds that are expected to increase intracellular H\textsubscript{2}S production augment hypoxic responses. Further, drugs that inhibit H\textsubscript{2}S production inhibit hypoxic responses. Previous work has also shown a correlation between hydrogen sulfide and Protein Kinase Cε (PKCε). H\textsubscript{2}S has been shown to activate PKCε in the myocardium, with PKCε having a role in ischemic conditioning. This suggests the activation of PKCε by H\textsubscript{2}S in the oxygen sensing cascade in both pulmonary vessels and the myocardium. Under normoxic conditions, PKCε exhibits membrane binding when exposed to H\textsubscript{2}S. We wanted to explore the possibility of PKCε membrane binding in hypoxia (1% O\textsubscript{2}). Our research showed a significant amount of translocation to the plasma membrane from PKCε in hypoxia, displaying another correlation between H\textsubscript{2}S and the oxygen-sensing mechanism.

What inspired you to participate in undergraduate research?
“I love solving puzzles and being about to conduct research that no one else has done before. The white coats are pretty awesome too.”

How did you get your research position, and what preparation did you undertake for it?
“I have researched in Dr. Kenneth Olson’s lab since my freshman year. I knew that I wanted to continue my research into the summer, so I submitted a proposal to the College of Science and received the College of Science Summer Undergraduate Research Fellowship to fund my work.”

Where was your research experience located?
“Indiana University School of Medicine- South Bend”

What did you get out of your research experience?
“I learned so much about the nature of scientific research. It is amazing to be able to come up with your own research questions, and to be able to answer them in a laboratory. I also learned about failure. In research, it almost seems like you fail more than you succeed, but if you are able to pick yourself up and learn from your mistakes, your success will be that much more meaningful.”
What Makes a Pest Species? Olfactory Receptor Comparisons Between a Pest and Non-Pest Fruit Fly Species Drosophila melanogaster and Drosophila suzukii

Cole Johnson
Major: Biological Sciences
Advisor: Zainulabeuddin Syed, Dept. of Biological Sciences, University of Notre Dame
Coauthor: Paul Hickner, Dept. of Biological Sciences, University of Notre Dame

*Drosophila suzukii* is an invasive pest fruit fly species. Unlike most of the other 1,500 species of saprophytic fruit flies, *D. suzukii* females oviposit in ripe, soft skinned fruit. This behavior has significantly harmed crop yields in recent years and poses a major agricultural and economic problem. Current control methods include nonspecific pesticides and insecticides. The Syed Lab is focused on developing olfactory-based techniques to specifically monitor and control this species, as olfaction is critical for many life history traits in *D. suzukii*. This study aimed to identify candidate olfactory receptor genes that may contribute to the pestiferous behavior of *D. suzukii*. First, we conducted genome analysis and annotation to verify the presence of olfactory genes in *D. suzukii* and identify homology between *D. suzukii* and *D. melanogaster*. We then targeted a subset of olfactory receptors (*Or22a, Or67a, Or67b, Or67c, and Or67d*) for expression analysis in *D. suzukii* based on genomic changes and functional data. RNA was extracted from the third antennal segment and a cDNA library was generated. Future qPCR analysis of the *Ors* of interest will be performed in both *D. suzukii* and *D. melanogaster* to compare expression levels.

**What inspired you to participate in undergraduate research?**
I wanted an independent project has the potential to contribute to meaningful change. I was interested in applying knowledge I had learned to a real-life problem.

**How did you get your research position, and what preparation did you undertake for it?**
“I met Dr. Syed at the Biology Networking Dinner my first semester at Notre Dame. I was interested in his work, and joined his lab the following semester. Once I had several semesters of experience, I felt I was ready to have my own project. I applied for and was awarded a 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 learned a lot about the day-to-day activities of people who work in labs. I learned how to handle challenges and curveballs in the progress in my research, and developed valuable career discernment knowledge in the process.
The Mechanism of High-Dose Ibuprofen as a Cystic Fibrosis Anti-Inflammatory Drug

Claire Kampman
Major: Biological Sciences
Advisor: Thomas Kelley, Dept. of Pediatrics, Case Western Reserve University
Coauthor: Sharon Rymut, Dept. of Pediatrics, Case Western Reserve University

The primary cause of morbidity in Cystic Fibrosis (CF), a genetic respiratory disease, is inflammation, with only one existing approved anti-inflammatory drug—high-dose ibuprofen. The off-target mechanism of ibuprofen is unknown, although it may impact the RhoA pathway, an inflammatory pathway whose defects confer slower rates of microtubule polymerization in CF. We hypothesize that ibuprofen interacts with CF microtubules through the Stathmin-1 pathway to stabilize microtubules and ameliorate inflammation. Microtubule polymerization assays were conducted by polymerizing cells in warm media at variable time-points and observing rates across untreated vs. ibuprofen treatments. Ibuprofen corrected CF cell microtubule polymerization rates to wild-type rates. To elucidate the mechanism, western blots were run with human trachea epithelial cells co-treated with ibuprofen and several common kinase inhibitors and probed for Stathmin-1, a microtubule tear-down protein. Overall, ibuprofen increased levels of phosphorylated (inactive) Stathmin-1. When co-treated with AMP Kinase inhibitor, this increase reverted to wild-type levels. In conclusion, we suggest that high-dose ibuprofen acts as an AMPK agonist to stabilize CF Cell microtubules by the inactivation of Stathmin-1. More research should be done to elucidate the precise interaction between ibuprofen and AMPK, and to investigate known AMPK agonists and their impact on CF cell microtubules.

What inspired you to participate in undergraduate research?
“I wanted to have learning experiences outside of the classroom lecture-and-exam style. I love learning by doing, and undergraduate research seemed like the perfect way to do that.”

How did you get your research position, and what preparation did you undertake for it?
“I connected with Dr. Kelley through a class of ’15 Notre Dame student who had worked for him in the past. I also have a personal connection to Cystic Fibrosis, which drove my scientific interest. CWRU is in my hometown of Cleveland, Ohio, so I visited the lab over my winter break and was accepted into a research program there for the following summer.”

Where was your research experience located?
“Case Western Reserve University in Cleveland, OH.”

What did you get out of your research experience?
“I learned so much about experimental design and data analysis by working through the processes everyday for two summers. Beyond this, I also was awarded a grant for the summer of 2015, and my project is part of a pending publication. Above all, though, I made some great friends in my lab and was able to explore a different part of my hometown, all while establishing a life-long love of research.”
Regulatory gene expression in the Aedes aegypti retina

Audrey Kelly  
Major: Biological Sciences  
Advisors: Michelle Whaley and Joseph O’Tousa, Dept. of Biological Sciences, University of Notre Dame

Aedes aegypti is the insect vector for both dengue and yellow fever, two tropical diseases which have seen alarming resurgences in recent years due to factors such as increased global travel and climate change. The visual system of Aedes is thought to be important to its competence as a vector and is unusually complex. The Aedes adult retina is partitioned into four distinct regions based on the opsin expressed in the 7th photoreceptor (R7): the dorsal region, the central region, the ventral stripe, and the ventral region. In this study, in situ hybridization was used with the adult retina to elucidate the roles of five transcription factors known to contribute to retinal patterning in Drosophila. While probes for wingless, homothorax and orthodenticle did not result in staining specific to R7, initial trials with Iroquois complex and spineless suggest that these genes may contribute to the patterning of the dorsal and ventral regions and the dorsal region, respectively. Future directions for this study include perfection of experimental technique and hybridization with the larval retina, a stage wherein the transcription factors may be expressed at a more significant level as the compound eye develops.

What inspired you to participate in undergraduate research?
I shadowed in a hospital in rural Tanzania the summer after my sophomore year and became really interested in dengue fever vector control research because all of the doctors I met really emphasized how important it was to controlling the disease. Dr. O’Tousa’s lab was a perfect fit for me as they study vision and vector competence in the mosquito that carries dengue.

How did you get your research position and what preparation did you undertake for it?
I have been a member of the O’Tousa lab since the summer of 2014 and have been working on my thesis since the fall of 2014. I wrote and submitted a research proposal based on my research during the 2014-2015 academic year and the Glynn Family Honors program provided funding for my project.

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

What did you get out of your research experience?
I was able to dedicate 40 hours a week to working on my thesis project, to work with faculty that are distinguished in their field and to meet and be around students also interested in research; I also gained technical laboratory skills and refined my ability to write and read scientific literature.
Synthesis of UV-Active Cholesterol Mimic for Study of Niemann-Pick Type C Disease

Luke Kiefer
Major: Science-Business
Advisor: Paul Helquist, Dept. of Chemistry and Biochemistry, University of Notre Dame

KLG-1[(1R,11aR)-7-methoxy-11a-methyl-1-(5-methylhexyl)-2,10,11,11a-tetrahydro-1H-naphtho[1,2-g]indole], is a cholesterol mimic with strong UV-activity. It can be used as a biomarker for monitoring of cholesterol trafficking in situ. The synthetic pathway of KLG-1 utilizes a stereo-selective Michael addition and a reductive imine cyclization. The ability to visually study the trafficking of cholesterol has abundant potential for application in various biological pathways in which cholesterol is involved, both on the micro and macro levels. One of the various goals of monitoring cholesterol trafficking is to advance understanding of the rare disease Niemann-Pick Type C. While this disease’s primary cause is a genetic abnormality in the NPC1 or NPC2 genes, the proteins which the genes code for are highly involved in cholesterol trafficking through lysosomes. The defective genes create malfunctioning proteins which are unable to transport cholesterol, leading to its accumulation and the neurodegenerative symptoms which affect those suffering from the disease. Hopefully, KLG-1 will both benefit the study of maladies resulting from deficient cholesterol trafficking and serve as a model for engineering and application of future biomarkers.

What inspired you to participate in undergraduate research?
I had been disinterested as a freshman towards the prospect of doing research, but during the summer before my sophomore year, I met the Leoni family whose daughter was afflicted with Niemann Pick Type C (NPC). I met Dean Crawford with them as well as he started his bike ride across the country for NPC. After talking with Dean Crawford and the Leoni family, I realized that this was a cause I wanted to get behind, and I felt drawn to doing research to help the cause.

How did you get your research position, and what preparation did you undertake for it?
After meeting Jessie Leoni, I kept in contact with Dean Crawford through first semester of sophomore year, and he steered me towards Professors Helquist and Wiest. After talking with them, they gladly accepted me into their group to work on this cholesterol mimic project.

Where was your research experience located?
University of Notre Dame

What did you get out of your research experience?
I have become close with everyone in my lab group, and I have expanded my knowledge of organic chemistry reactions. The greatest part so far was participating in a national NPC conference in June held at Notre Dame where I met and listened to many professors and doctors working on all different projects towards treating NPC.
Exploring the Protein Folding Mechanism: SAXS Versus FRET

Catherine Knoverek
Major: Biochemistry
Advisor: Patricia L. Clark, Dept. of Chemistry and Biochemistry, University of Notre Dame
Coauthors: Micayla A. Bowman, James R. Hinshaw\textsuperscript{1}, Josh Riback\textsuperscript{2}, Emily B. Kaye, Adam Zmyslowski\textsuperscript{3}, & Tobin R. Sosnick\textsuperscript{2,3}
Departments of \textsuperscript{1}Chemistry, \textsuperscript{2}Institute for Biophysical Dynamics, \textsuperscript{3}Biochemistry and Molecular Biology, University of Chicago

There is conflicting data concerning the unfolded state in studies of protein folding, which is currently assumed to be equal to the denatured state. Small angle X-ray scattering (SAXS) data suggests that most, but not all, proteins do not undergo an initial collapse when transferred from high to low denaturant conditions before folding. This is contrary to Förster resonance energy transfer (FRET) experiments that have consistently demonstrated polypeptide collapse after dilution from denaturant and before folding. In order to put to rest these discrepancies, it is necessary to identify a negative control that will not show collapse regardless of what technique is used. Here we describe a polypeptide candidate for that control. Normally, the passenger domain of the autotransporter protein pertactin is a 16-rung, right-handed β-helix. When the 334 amino acid N-terminal portion (PNt) is separated from the rest of the protein, it does not adopt any regular structure independent of the presence of denaturant. This has been shown using tryptophan emission fluorescence and far-UV circular dichroism. Initial SAXS experiments performed on a PNt fragment unlabeled and singly labeled with a commonly used FRET dye suggest no effect of the presence of one label. However, more SAXS and FRET experiments will need to be performed in order to determine the source of the SAXS/FRET discrepancy.

What inspired you to participate in undergraduate research?
I was interested in possibly pursuing research as a career and joining a lab was the best way to find out if that path was right for me. It was also a great way to get exposure to biochemistry before taking the required courses.

How did you get your research position, and what preparation did you undertake for it?
I met with Dr. Clark and she told me about the research that was currently being done in the lab. It sounded interesting, and she was happy to let me join the lab. I spent about a year training—learning techniques and how to use the equipment. After another semester of designing and planning a project, I began my work.

Where was your research experience located?
University of Notre Dame

What did you get out of your research experience?
My research experience has really strengthened my undergraduate education. I have learned a lot about the field, about scientific research, and about myself. It has helped me in my decision to pursue graduate education and will also strengthen my graduate applications.
This study aimed to determine the effect of increased documentation of smoking history and increased discussion of cessation options among patients at a non-denominational faith-based homeless shelter outpatient clinic managed by medical and PA students. Students instructed to refer smokers to a three+ week program, weekly support group, or individual counseling. A review of electronic health records (EHRs) was conducted across the patient encounters (N=528) to determine the frequency with which smoking history and cessation programs were documented in SOAP notes before and after intervention. Among the 477 patients with valid visits, 178 (37.8%) of patients had a smoking history listed. Among the 178 patients with indicated smoking history, 119 (66.9%) of patients were current smokers. Among the 119 patients identified as current smokers, 30 patients (25.2%) had information about smoking in the Subjective portion of the SOAP note. Among the 119 patients identified as smokers through the smoking history (social history) listed on the patient chart, 5 patients (4.4%) had a smoking cessation attempt listed in the Plan portion of the SOAP note. Our results are similar to national estimates that 70% of homeless men identify as smokers. With a tobacco cessation attempt documented among only 4.4% of smokers, there is a need for training providers to become more comfortable with discussing smoking cessation with their patients and refer patients to an established cessation program.

What inspired you to participate in undergraduate research?
“It offers an amazing opportunity to get a good look into what my future career might be like.”

How did you get your research position, and what preparation did you undertake for it?
“My summer internship included a combination of shadowing, quality improvement (QI) research, and data analysis. I took particular interest in this study and was asked if I would like to participate in the study in a higher capacity.”

Where was your research experience located?
“University of Texas Southwestern Medical Center, Dallas, TX”

What did you get out of your research experience?
“An awesome summer job and the ability to explore the complex web that is the public health care system.”
Intravital imaging of the immune response to nanoparticle-based vaccines in the mouse uterine mucosa using two-photon microscopy

Lydia Koroshetz
Major: Biological Sciences
Advisor: Rodrigo Gonzalez, Uli von Andrian Laboratory, Harvard Medical School

The mucosae line body cavities and are consequently exposed to the external environment. Pathogens can enter via the mucosae and cause disease in the host, an example being the sexually transmitted pathogens that infect the female genital tract. Vaccines can protect against infections by establishing an adaptive memory response against these pathogens. Nano carriers have proved to be effective vehicles for delivering antigen and developing immunity in the uterine mucosa against Chlamydia trachomatis, the most common cause of bacterial sexually transmitted infections. There is very little known about how antigens interact in the mucosa of the female genital tract and how manipulation of these interactions can result in long lasting immunity. Our goal was to develop a system for intravital imaging of host-antigen interactions in the uterine mucosa of mice exposed to nanoparticle-based vaccines using two-photon microscopy.

What inspired you to participate in undergraduate research?
I have always been interested in immunology and was excited at the opportunity to work in a lab that strives to answer the many mysteries of the immune system. I am particularly attracted to research that is able to advance scientific and medical knowledge, especially in ways that will improve health and pave the way for novel treatments for disease.

How did you get your research position, and what preparation did you undertake for it?
I applied and was accepted into the Harvard Immunology Undergraduate Research Program.

Where was your research experience located?
Harvard Medical School in Boston, MA

What did you get out of your research experience?
This internship allowed me to continue my study of the immune system through basic research. More importantly, it provided the opportunity to work alongside dedicated, world-class research associates at one of the top immunology programs in the nation. I was impressed by and admired the other researchers in my lab who demonstrated such hard-work and passion for their projects.
The Effect of Plasma Radiation on Nucleobase and Plasmid DNA Solutions

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

Created when a gas is flowed through a large potential difference between two high-voltage electrodes, plasma is known as the fourth state of matter and is composed of a variety of reactive species. The UV light, neutrals, electrons, electromagnetic fields, and ions produced by the ionization of the gas can be directed towards samples and have been shown to have a potent biological effect. Recently, studies have shown that treating biological tissue with plasma selectively induces apoptosis in exposed cancer cells. Apoptosis is known as controlled cell death, which minimizes the trauma associated with necrosis and allows cell constituents to be recycled by the neighboring tissue. Because the apoptotic pathway is opened at a higher rate in cancer cells than in healthy cells, plasma has potential to serve as both an epithelial cancer treatment and a therapy to restore effectiveness of various chemotherapies. This project aims to study the effect of plasma radiation on solutions of independent nucleobases and then on solutions of plasmid DNA, in an effort to mirror the cellular conditions of a fundamental level. Several reactive species are known to trigger apoptosis, and the production of hydrogen peroxide, nitrate, nitrite, and hydroxyl radical production were observed as a function of irradiation time. With increased radiation exposure, it was seen that the concentrations of these radicals increases proportionately. Measurements are ongoing to relate the presence of these reactive species to the observed DNA damage. When complete, this project could show which reactive species are most responsible for plasma-induced apoptosis.

What inspired you to participate in undergraduate research?
Research provides you with the opportunity to question the current knowledge and convention surrounding a topic and really push the boundaries of what we know. This has always been exciting to me and being able to creatively plan and design experiments is incredibly rewarding when you see them come to fruition.

How did you get your research position, what preparation did you undertake for it?
My high school required a professional internship before graduation during our senior year, and so I reached out to some professors I met during visitation to see if I could intern in a lab at Notre Dame. Thankfully, Prof. Ptasinska was willing to take me into her lab for a two-week internship and then offered me a research position the following fall when I came to Notre Dame for my freshman year. I’ve been working with her group ever since!
To prepare for my research position, I read a large amount of literature from the field and did my best to familiarize myself with the language and science of the field. However, a lot of my learning about biophysics research came from my first months in the lab and just working with the projects on a daily and weekly basis.

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

What did you get out of your research experience?
It’s always fun to spend a summer at Notre Dame! Working full time for 10 weeks on this project allowed me to make a tremendous amount of progress and taught me how to manage and schedule my time in the lab. I’m now learning how to write up results and publish my data – great preparation for my future graduate studies!
The Effects of Sphingosine-1-Phosphate in the Amygdala

Ashley Kyalwazi and Daniel Kendall
Majors: Neuroscience and Behavior
Advisor: Patrick Sheets, Dept. of Biological Sciences, University of Notre Dame and Indiana University School of Medicine-South Bend.

There is a plethora of research describing the mechanisms of pain hypersensitivity and chronic pain caused by abiding changes to the peripheral nervous system following inflammation and injury. Unfortunately, there is a significant gap in knowledge regarding the mechanisms whereby inflammatory injury alters specific supraspinal pathways relevant in pain processing. Sphingosine-1-phosphate (S1P) is a bioactive lipid involved in innate immunity and wound healing. S1P is secreted from mast cells upon detection of pathogenic or allergenic antibodies and following acute tissue injury. Secreted S1P significantly contributes to the inflammatory response by receptor-mediated recruitment and activation of T cells, macrophages, and B cells. Additionally, activation of S1P receptors produces an increase in excitability in peripheral sensory neurons and drives pain behavior following peripheral tissue injury. Although S1P receptors are expressed throughout the central nervous system (CNS), nothing is known about the effects of S1P on defined pathways within supraspinal pain circuits. S1P receptors are found in the amygdala which is a key substrate in the connection between pain and affective behavior. The central nucleus of the amygdala (CeA) contains a major subpopulation of GABAergic neurons that disinhibit the periaqueductal gray (PAG) which is a midbrain structure essential in the function of the endogenous analgesic system. This disinhibition leads to analgesia and the expression of fear behavior. Our central hypotheses are that S1P decreases the excitability and synaptic transmission of CeA-PAG neurons and that inflammatory injury induces long-lasting sensitization of CeA-PAG neurons to S1P. Here, we used a combination of retrograde labeling and slice electrophysiology to measure the effects of S1P on neurons within different regions of the amygdala. Our findings show that in a mouse model of inflammatory pain, S1P hyperpolarizes CeA-PAG neurons leading to a decrease in excitability. This suggests that S1P reduces amygdalar output to the PAG. This reduction in amygdala to PAG signaling may have important implications as to the role of S1P in the processing of pain in supraspinal circuitry.

What inspired you to participate in undergraduate research?

Ashley: “The idea of formulating my own questions and then testing those ideas out in lab has always fascinated me. I was eager to challenge myself in the field of Neuroscience—something I had never done before—and deepen my understanding of the brain.”

Daniel: “I really enjoyed my undergraduate lab courses, especially in Biology and Neuroscience, and I saw undergraduate research as a valuable chance to expand on my lab skills and knowledge.”

How did you get your research position, and what preparation did you undertake for it?
Ashley: “The first semester of my Freshmen year, I met with Dr. Michelle Whaley and asked her how best to find a lab/get involved in Undergraduate research. I also spoke with my friend, Michael Dinh, about finding a Neuroscience lab. I was advised to contact Dr. Sheets, and from there we began to communicate back and forth about my interests. I then began attending lab meetings—taking notes and reading related papers—until I was offered a spot in the lab.”

Daniel: “I first contacted Dr. Sheets in January of 2015 in order to inquire about joining his lab. After meeting with him and explaining my intentions to join a Neuroscience Lab at Notre Dame we both agreed to meet weekly throughout the semester to go over relevant literature relating to the research questions posed in the Sheets lab. After this trial phase, Dr. Sheets offered me a position for the Fall 2015 semester in his lab at IUSB.”

Where was your research experience located:

Both: “Raclin Carmichael Hall- Indiana University Medical School”

What did you get out of your research experience?

Ashley: “Research in the Sheets Lab has definitely broadened my understanding of the both the mouse and human brain. In addition, I have learned a great deal of electrophysiology and the science behind the techniques that are employed in the lab.”

Daniel: “My experience in undergraduate research has been truly rewarding so far. In my "trial" period I got one on one experience analyzing complex research papers related to neural pathways of pain. Since becoming a member of the lab this fall I have observed and learned many research skills that I will further develop throughout my participation in Dr. Sheets' lab for the next three semesters. I look forward to building on my prior knowledge of Neuroscience through this research experience.”
Bronchopulmonary dysplasia (BPD), the chronic lung disease associated with premature birth and postnatal exposure to hyperoxia, is due to impaired vascular and alveolar growth. Studies using animal models suggest that Mesenchymal stromal cells (MSCs) have the ability to promote lung tissue regeneration by augmenting vascular growth and secreting protective immunological factors. The finding that MSCs play a role in lung development suggests that abnormalities in the levels present in preterm infants may contribute to lung injury seen in BPD. However, the effect of hyperoxia on MSCs has not been studied. In this study the growth of isolated and characterized umbilical cord-derived MSCs from term and preterm infants under room air and hyperoxic conditions was assessed. Additionally, the potential of conditioned media (CM) from MSCs maintained at room air and hyperoxia to stimulate growth of mature human umbilical vein endothelial cells (HUVECs) was analyzed. Results suggest MSC growth is significantly decreased under hyperoxia conditions, cell growth and wound-healing response is greatest in 2.5% CEGM-2 room air media, and that MSC conditioned media does not stimulate growth of human umbilical vein endothelial cells (HUVECs) when compared with standard HUVEC growth media (2.5% CEGM-2).

What inspired you to participate in undergraduate research?
“The opportunity to think critically about questions that arise in science, particularly in medicine, and apply a variety of methods to make advancements in a field.”

How did you get your research position, and what preparation did you undertake for it?
“I applied for the Webb-Waring Colorado Undergraduate Summer Program. The summer after my freshman year I was in a translational research lab where I was introduced to the concept of stem cell therapy. I started doing research my sophomore year in the Panopoulos lab, and was able to further my knowledge on how stem cells work. This knowledge helped me jump right into my summer project working with MSCs.”

Where was your research experience located?
“University of Colorado School of Medicine”

What did you get out of your research experience?
“The opportunity to develop and expand upon my lab skills with greater independence, a deeper appreciation of the fact that medicine and research are so intertwined, and a better understanding of how research allows for therapeutic advances in medicine.”
Recent research has shown that high-index (557) Platinum surfaces will undergo surface reconstruction in the presence of 0.5 ML coverages of Carbon Monoxide (CO). We present molecular dynamics simulations of Pt(321), Pt(112), Pt(765), and Pt(557) surfaces with varying coverages of CO. Density functional theory and experimental adsorption data were used to parameterize the Pt-CO binding interaction. The surfaces were chosen because of the variety of step edges and kink sites they contain, which make useful models for industrial catalysts. These features make the reconstruction of these surfaces of particular interest since catalytic activity and selectivity depends on the displayed facet. Our preliminary results indicate that the kinked steps on Pt(321) and Pt(765) increase the likelihood of surface diffusion and step doubling compared to the flat, (100), steps on Pt(112) and Pt(557).

**What inspired you to participate in undergraduate research?**
I wanted an opportunity to apply my skills in mathematics and chemistry to real world problems.

**How did you get your research position, and what preparation did you undertake for it?**
I joined Professor Gezelter’s group in September 2014; therefore, my work this summer was a continuation of the research I had already began. My research was funded by the Notre Dame College of Science Summer Undergraduate Research Fellowship, which agreed to fund my proposal to extend my academic-year research into the summer.

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

**What did you get out of your research experience?**
I gained valuable experience as I learned how to work in the lab on a daily basis. I became more independent throughout the summer. For example, I grew comfortable searching literature to answer my questions instead of always relying on help from more senior group members. The experience that I gained this summer has led me to consider graduate school in the future.
In areas of the world where resources are scarce, subpar pharmaceuticals pose challenging problems. Specifically, subpar drugs prolong sickness, cause harmful side effects, and increase drug resistance. In low resource areas, it is difficult to procure technical expertise and expensive technology needed to assay the contents of pharmaceuticals. Our lab uses paper analytical devices (PADs) to assess drug quality. Paper is relatively cheap, amenable to advances in printing, and allows a wide range of chemical and biochemical moieties, including whole cells, to be attached to its surface for pharmaceutical analysis. To harness the combined sensitivity and specificity of biological systems, our lab developed the first whole-cell yeast PAD (BioPAD) for detection of tetracycline antibiotics. The device is a piece of paper about the size of a playing card, which hosts yeast cells genetically engineered to produce a visible blue reporter in the presence of tetracycline antibiotics. While this system is useful for demonstrating the basic feasibility of BioPADs, the particular reporter is not field friendly because it takes upwards of eight hours to develop and requires cells to be lysed with nitrogen. In light of these limitations alternative reporters are being investigated. Specifically, EGFP (Enhanced Green Fluorescent Protein) has been cloned into the tetracycline vector to decrease response time. In the presence of tetracycline, the EGFP gene produces a fluorophore which can be detected using an LED light. Currently, visualization strategies for this reporter are being developed. In addition, RFP (Red Fluorescent Protein) has been cloned into the tetracycline vector to more easily distinguish the reporter response from background fluorescence. These developments will optimize the field friendly and user friendly aspects of the BioPAD.

**What inspired you to participate in undergraduate research?**

“I love to test out what I have learned in the classroom in the real world. Undergraduate Research is a good way to develop a skill set and gain perspective for further studies in the future.”

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

“This past summer I participated in the Analytical Chemistry for the Developing World NSF REU. At the end of the summer Dr. Goodson asked if I would like to continue the research, and I readily agreed.”

**Where was your research experience located?**

“University of Notre Dame”

**What did you get out of your research experience?**

“Research has given me the opportunity to test my skills in the real world. It has also inspired me toward further research and academic growth. I have many new friends and connections, and would highly recommend research at Notre Dame to anyone.”
The effect of flowering plant density, location, and fitness on pollinator visitation rates

Hannah Legatzke
Majors: Environmental Science and Anthropology
Advisor: Hannah Madson, Dept. of Biological Sciences, University of Notre Dame

Patterns in pollination influence the reproductive success of many plant species. Optimal foraging theory predicts that pollinators that gather resources efficiently are favored by natural selection. Therefore, we expect that high density patches of plants and/or flowers will be visited more frequently because they provide pollinators with more resources per search and travel time.

We conducted observations of (1) a manipulated population of *Hieracium aurantiacum* L. (*Asteraceae*) to study how pollinator recruitment and visitation rates are affected by flower density, and (2) a naturally distributed population of *Barbarea vulgaris* L. (*Brassicaceae*) to study how the relative location, density, and fitness of individual plants affect visitation rate. For *H. aurantiacum*, patches with high flower density recruited more pollinators and were visited more frequently, especially during times of day with higher light availability. In *B. vulgaris* visitation rate was correlated with the number of open flowers on an individual plant, but was independent of a plant’s location in the population, the distance to its nearest neighbor, height, and whether its patch had many or few plants and flowers. This study suggests that flower number within a small area or on an individual is one factor that influences pollinator visitation.

What inspired you to participate in undergraduate research?
“*I was intrigued by the process of developing my own question, then addressing the methods to solve it. I wanted to experience field research particularly, and add new perspectives to my ideas about research from lab course work.*”

How did you get your research position, and what preparation did you undertake for it?
“I applied to Practicum in Field Environmental Biology East course in the fall of my sophomore year. The course walks you through the research process under a mentor, and has four ecology modules that provide helpful background information on the systems you are studying.”

Where was your research experience located?
“University of Notre Dame Environmental Research Center in Land O’Lakes, WI.”

What did you get out of your research experience?
“I made great friends, got to explore picturesque wilderness, saw my own research project from start to finish, and achieved a working knowledge of Excel and SYSTAT.”
The effect of parity on ovarian cancer metastasis

Annemarie Leonard
Major: Biochemistry
Advisor: Sharon Stack, Dept. of Chemistry and Biochemistry, University of Notre Dame
Graduate Student Advisor: Elizabeth Loughran, Dept. of Chemistry and Biochemistry, University of Notre Dame
Coauthors: Ryan Phan

Epithelial ovarian cancer (OvCa) is the most common subtype of ovarian cancer. OvCa often goes undetected until metastatic stages of the disease, contributing to the high mortality rate of OvCa patients. OvCa exhibits a unique form of metastasis initiated by the shedding of tumor cells or multicellular aggregates (MCAs) from the primary tumor into the peritoneal cavity. The peritoneum is a serous membrane that lines the abdominal cavity, consisting of a single layer of mesothelial cells (MCs) supported by a collagen-rich extracellular matrix (ECM). It has been noted that pregnancy reduces ovarian cancer risk with greater protective effect accompanying more births. During pregnancy, hormonal changes influence the behavior of resident cells, such as peritoneal macrophages, and the growing fetus exerts strain on the walls of the peritoneum. To further investigate the role of parity in OvCa metastasis, we designed a study comparing age-matched nulliparous (V), parous 1 (P1), and parous 3 (P3) mice. We tested the effect of parity on metastasis in vivo with an ID8 allograft study carried out in V, P1, and P3 mice. P3 mice displayed significantly less tumor burden, notably in the visceral fat surrounding the ovaries.

What inspired you to participate in undergraduate research?
As an aspiring doctor, I desire to be on both ends of my career path. I not only want to obtain a mastery of the diagnostic skills in medicine, but also desire to contribute to making advancements in the field of medicine. I believe that participating in both the practice of medicine and contributing to the advancements in medicine will help me become the best doctor that I can be as I will have an understanding of problems from both perspectives. Since research is a vital component to making advancements in the scientific world, I was inspired to participate in undergraduate research so I can develop skills that will allow me to work on both sides of the medical field.

How did you get your research position, and what preparation did you undertake for it?
I have been a member of the Stack Lab since May of 2015, and I have loved every moment! By applying the basic laboratory skills that I learned in my coursework, I have been able to perfect those techniques and apply those skills in learning other techniques.

Where was your research experience located?
Harper Cancer Research Institute at the University of Notre Dame.

What did you get out of your research experience?
Aside from an amazing summer at Notre Dame, new friends, and new collaborators, I also learned how to analyze data and perform an array of laboratory techniques such as mouse dissection and cell culture. My research experience in the Stack Lab is providing a solid basis for my future endeavors toward becoming a doctor.
Phosphorus is an essential nutrient used by plants in many processes including photosynthesis and nitrogen fixation. Phosphorus added to soil in the form of fertilizer can be lost through surface runoff and subsurface flow, and carried into nearby aquatic ecosystems. The role of tile drainage in phosphorus loss has only recently begun to be thoroughly investigated. This project’s primary objective was to determine a baseline for how soil management and properties affect phosphorus leaching in a no-till agricultural system. Field measurements were taken at 10 field sites on Burnett Farm, Massac County, IL. To assess the effect of management practices on the fields, relative amounts of phosphorus leaching from each field were determined. Fields with heavy manure application tended to have higher soil P levels and higher DRP and TP levels in tile drainage. Some fields showed unexpectedly high levels of soil P and DRP, including a field planted with wheat. Soil P alone does not seem able to account for differences in DRP and TP levels found in the tile drains. Possible variables affecting leaching include crop type and soil series. Soil texture greatly influences P leaching from the soil so more in-depth textural analysis would be warranted.

What inspired you to participate in undergraduate research?
“I was interested in agricultural systems, and wanted to know more about the process of agricultural research. I really enjoy the process of learning all about a specific topic and then using it to try to make sense of data.”

How did you get your research position, and what preparation did you undertake for it?
“I applied to the NSF funded summer REU program at Southern Illinois University. Previously, I had worked as an ecology undergraduate research assistant in the Rocha lab for one semester and for two weeks in the summer, and I also worked on a cancer group research project with Zhang Lab for my cell biology lab credit for biological sciences majors.

Where was your research experience located?
“Southern Illinois University - Carbondale”

What did you get out of your research experience?
“I got to experience the varied natural ecosystems of Southern Illinois, and learned about field and lab work in a variety of ecology related disciplines. Interacting with the farmer whose field I was working on helped me understand how non-scientists view research. I learned that I am definitely interested in doing more research in the future!”
Association of somatic mutations in translation initiation sites with tumorigenesis

Xuanyi Li
Major: Computer Science
Advisor: Roeland Verhaak, Dept. of Genomic Medicine, MD Anderson Cancer Center

Translation initiation mechanism in eukaryotes is typically described as the scanning model where the small (40S) subunit of ribosome scans in 5’ to 3’ direction, starting at the capped 5’ end of mRNA and stopping at the first start codon (AUG)\(^{(1)}\). However, the first start codon rule is not absolute. The sequence flanking a start codon, namely the translation initiation site (TIS), governs the probability of translation initiation at that start codon\(^{(2)}\). TIS mutations could alter translation efficiency and gene expression and is a possible cause of human diseases\(^{(3)}\). In this project, the link between somatic TIS mutations and tumor development is assessed. The aim is to explore the possibility that TIS mutations in cancer-related genes could promote tumorigenesis.

What inspired you to participate in undergraduate research?
As a computer science major, I want to explore the application of computer power to solving biological questions. I am interested in cancer research because I see cancer as both a devastating disease and an interesting problem. For me working on cancer research project is both meaningful and intellectually stimulating.

How did you get your research position, and what preparation did you undertake for it?
I participated in the Notre Dame MD Anderson Cancer Center joint summer research program, which provided me the opportunity of working at MD Anderson Cancer Center for 10 weeks this summer. To make the most of my time there, I contacted my advisor, Dr. Roeland Verhaak, before I arrived in Houston to learn about my project. I was able to read relevant papers and contemplated on my project my 10-week program.

Where was your research experience located?
MD Anderson Cancer Center

What did you get out of your research experience?
I had the chance to work at a world-class cancer research center and learnt about the latest development in cancer research. I was able to work on a project individually with the support of my advisor and his post-doctoral fellow.
A Correlation between Religiosity and the Utilization of Healthcare by Undergraduate Students

Danielle Lukish
Major: Preprofessional Science and Spanish
Advisor: Jessica Collett, Dept. of Sociology, University of Notre Dame

Over 15 million young adults between the ages of 18 and 24 attend an institute of higher education (IHE). With the implementation of the Affordable Care Act, there is interest in the utilization and overall health of undergraduate students in order to optimize care and costs. Insight regarding predictors of overall health and utilization of student health services (SHS) is critical in this endeavor. A religious factor has been previously shown to be a predictor of improved overall health and outcome. The specific aim of this study was to evaluate the subjective religiosity of undergraduate college students and to determine if this factor is predictive of personal health and utilization of SHS. An internet-based survey was developed to evaluate multiple viewpoints of undergraduate college students at the University of Notre Dame, the University of Maryland, and Johns Hopkins University. The principal investigator distributed the survey and student participation was voluntary and anonymous. The results indicated that a majority of undergraduate students remain healthy in college and do not develop a medical, surgical, or psychological problem. The majority also have a high religiosity score, meaning they believe in God, pray often, and regularly attend church. Data reported that this population also had a low likelihood of developing any type of medical issue during college. Such information may be beneficial in the allocation of healthcare resources amongst institutes of higher education so that they may better provide such resources to their patients.

What inspired you to participate in undergraduate research?
Since attending Notre Dame, my spirituality and connection to my faith have grown exponentially and caused me to question the role religion plays in a typical student’s life. While I am highly religious and believe my good health is directly correlated to it, I wanted to examine the undergraduate population at Notre Dame as a whole and see the correlation between their faith and health. After speaking with my father about the issue, he thought it would be cool to include a sample population from Hopkins and Maryland, two universities where my brothers go to school. As I got more involved in the data collection process at all three universities, my desire to continue and learn more increased immensely, ultimately driving me to finish this project ASAP.

How did you get your research position, and what preparation did you undertake for it?
Because my research is independent, I obtained the position fairly easily. I simply collaborated with my father and faculty mentor, designed the survey, and went from there. I spoke with Dr. Chaloner several times about methods of distribution and received great advice that I utilized in data collection. The preparation for obtaining IRB approval was definitely the most difficult step in the process. I worked on it over the summer in 2014 and received comments back from the IRB several times before it was completely approved. Like any aspiring research candidate, I also did an immense amount of independent research prior to creating my study design in order to have sufficient background knowledge of relevant studies on the correlation between religion and healthcare.

Where was your research experience located?
My research experience was located all over Notre Dame campus in various regions where I knew I could find a large population of students desiring to take my survey. At Hopkins and Maryland, I obtained such responses at their university libraries.

What did you get out of your research experience?
Overall, my research was an incredible learning experience and gave me an introduction to the IRB process and data collection/analysis. It also improved my communication skills with people and increased my knowledge on the best methods of obtaining responses from people in a timely manner. It was interesting to tour the campuses of University of Maryland and Hopkins, two schools that I had spent little time at in the past. Ultimately, the experience was extremely worthwhile and broadened my outlook on the various religious factors and their role in healthcare, two aspects of my life that I take great value in and always am interested in knowing more about.
Opioid Prescription Rate Variation by Geographic Region and by Prescriber Specialty

Kisa Matlin
Major: Environmental Science
Advisor: Todd B. Seto, Center for Outcomes Research and Evaluation, The Queen’s Medical Center
Coauthors: Deborah Taira Juarez, James W. Davis, and Todd B. Seto

Each year, nearly 17,000 Americans die from prescription opioid overdoses. Because opioid overdoses are directly related to the increased availability of prescription opioids, this study aimed to examine physician and state-level opioid prescription patterns. This study looked specifically at these prescription patterns in elderly adults using a large national database. To accomplish this, the 2013 Medicare Provider Utilization and Payment Data: Part D Prescriber Public Use File (PUF), which includes physician-level information on drug-specific prescription claims, was used to collect detailed information on all claims for the three most commonly prescribed opioids: hydrocodone, oxycodone, and tramadol. This data was then analyzed on the basis of prescriber specialty and by the states in which these drugs were prescribed. This study showed that prescription rates varied greatly by state. In hydrocodone and oxycodone, the prescription rates of the lowest and highest-prescribing states exhibited nearly a 10-fold difference and a 5-fold difference was shown in tramadol prescription rates. Rates by prescriber specialty also varied, with primary care physicians prescribing more opioids overall than surgical specialties. Of the primary care physicians, family medicine and internal medicine specialties accounted for the largest percentages of total opioid prescriptions.

What inspired you to participate in undergraduate research?
“As a pre-med student, I was interested in learning more about what research might look like in a hospital setting, especially with all the new changes and challenges in modern-day healthcare.”

How did you get your research position, and what preparation did you undertake for it?
“I contacted Dr. Seto through a family friend and he offered me a position for the summer. I spent the first couple of weeks as a research assistant in the clinical trials office at The Queen’s Medical Center providing assistance on many of their ongoing trials. After learning about the resources I had available, I submitted a proposal for my own project using the Medicare database.”

Where was your research experience located?
“The Queen’s Medical Center, Honolulu, Hawai’i.”

What did you get out of your research experience?
“The opportunity to complete my own research project, learn about clinical trials, shadow physicians, and foster relationships with current and future medical professionals in my home state of Hawai’i. I got to meet some truly wonderful individuals and learn more about the unique challenges that medical professionals in Hawai’i face.”
Preliminary haplotypes of the CD59 gene covering 23kb established in 10 Thai donors

Christine Mayuga
Major: Science Business, Statistics
Advisor: Willy Flegel, Department of Transfusion Medicine, National Institutes of Health
Coauthors: Alissa Hummer

Blood group systems are determined by the presence or absence of specific antigens on the surface of red blood cells. In 2014, CD59 was named as the 35th blood group system. The CD59 blood group system is encoded by the CD59 gene, which functions as a complement regulatory glycoprotein. The primary aim of this study was to amplify and sequence the CD59 gene and to resolve the CD59 gene haplotypes in a Thai population using MaCH and PHASE software. PCR amplification of the 23029 base pair coding region was performed on blood samples collected from ten Thai β-thalassaemia patients. The samples were then purified and sequenced. The preliminary sequencing of the CD59 gene in 10 Thai samples identified 48 single nucleotide polymorphisms. Both MaCH and PHASE identified 16 haplotypes. Variations in haplotypes predicted by MaCH and PHASE were due to differences in inferring missing genotypes. In the future, the missing genotypes should be identified and the haplotype analysis repeated to reduce such discrepancies. The results of this experiment can be utilized to compare haplotypes in different populations and to submit haplotype data to GenBank. Detailed haplotype information can be applied to computational approaches predicting CD59 antigens from next-generation sequencing data.

What inspired you to participate in undergraduate research?
“I experiencing the science I learn about in lecture firsthand. I am fascinated with how different projects can be applied for a greater purpose in treating diseases.”

How did you get your research position, and what preparation did you undertake for it?
“I applied for the Summer Internship Program at the National Institutes of Health in Bethesda. In addition, I emailed principal investigators pursuing projects that aligned with my interests.”

Where was your research experience located?
“I spent a summer in the Applied Proteomics and Molecular Medicine Department of George Mason University doing research on hydrogel nanoparticles. In addition, I worked with nanoparticles for my senior research project at my high school, Thomas Jefferson High School for Science and Technology. I also gained research experience in the Ferdig lab here at the University of Notre Dame.”

What did you get out of your research experience?
“Being at the NIH was certainly an unforgettable experience. I had the opportunity to be at the largest research center in the country, attend the lectures of incredibly accomplished scientists, and partake in a fun and rewarding internship program. I met many wonderful students will similar research and career goals.”
Three-Dimensional Printing of Soft Tissue and Tumor Models from PET/CT and STEALTH MRI Datasets using Native and Intravenous Contrast

Matthew McGoldrick
Biological Sciences and English
Advisor: W. Matthew Leevy, Department of Biological Sciences
University of Notre Dame
Coauthors: Ian Sander, Nathan Foje, W. Matthew Leevy

3D printing allows for the production of highly specific models that accurately represent the anatomical characteristics of a biological specimen. These models are of particular utility in the biomedical field, where they may facilitate research, device development, and medical treatment. Models may be produced from CT, PET, and STEALTH MRI datasets, all of which allow for the segmentation of specific soft tissues within a specimen. Segmented files may then be processed for 3D Printing. In X-Ray Computed Tomography (X-ray CT), native contrast may be used to isolate the lungs and brain; intravenous contrast agents allow for the isolation of the kidney, liver, heart and vasculature. A similar methodology may be used in PET and MRI datasets to delineate a tumor from surrounding tissues. The radioactive tracer Fluodeoxyglucose (FDG) may be used to highlight a tumor with Positron Emission Tomography (PET) for segmentation and model production. In addition, the more clinically relevant STEALTH MRI allows for segmentation of a tumor without the use of contrast agents. 3D printed models of tumors and their anatomical environments have high potential for use in patient communication, surgical planning, and education. Exploration into the ability to 3D print soft tissue models from clinical datasets will establish the potential of this process for use in the medical and research fields.

What inspired you to participate in undergraduate research?
I am fascinated by the processes of research and scientific exploration. The biomedical sciences, including biological imaging, anatomical modeling, and medical device development, are particularly engaging. My work in lab has allowed me to cultivate this interest by producing three-dimensionally printed models of anatomical structures.

How did you get your research position, and what preparation did you undertake in this role?
I have been a member of the Leevy Lab since the spring semester of 2015. I wanted to stay in lab over the summer to continue my research from the academic year and begin new projects with a greater focus on cancer and the clinical field. I submitted proposals to the Center for Undergraduate Engagement and the Harper Cancer Research Institute for summer funding. I was awarded fellowships from both the First Year of Studies and Harper Cancer Research Institute; my funding was also cost-shared by the College of Science and Center for Undergraduate Scholarly Engagement.

Where was your research experience located?
My research experience was located in the Galvin Life Sciences Center at the University of Notre Dame.

What did you get out of your research experience?
I learned how to pursue a project independently and adapt my thesis and goals to suit the progress of my research. I also learned how to collaborate with others and integrate advice and new ideas into my work. This work has provided me with valuable scientific skills and experience that will prepare for future endeavors in the fields of medicine and research.
Using patient-derived xenograft (PDX) models to study triple negative breast cancer

Elizabeth McGough
Major: Biological Sciences
Advisor: Helen Piwnica-Worms, Department of Cancer Biology,
University of Texas MD Anderson Cancer Center
Coauthors: Gloria Echeverria

About half of triple negative breast cancer patients will exhibit resistance to neoadjuvant chemotherapy, which demonstrates a critical need to understand how and why tumor resistance develops. Patient-derived xenografts were established from a patient’s treatment-resistant primary (PIM1-P) and metastasis (PIM1-M) tumors. Tumors, when implanted into the mammary fat pads of mice, retain many of the properties of the patient’s tumors. Genomic analysis revealed somatic mutations in these samples, including a frameshift insertion mutation in the tumor suppressor protein 53 (TP53) and restriction site associated DNA marker 50 (RAD50). Both genes are critical in the DNA damage response. Immunohistochemistry and western blotting revealed that levels of DNA double-strand breaks, apoptosis, and mitotic cells were similar between PIM1-P and PIM1-M tumors. Rad50 expression was uniformly observed across all samples, indicating that the mutant form of the gene does not impact the level of protein expressed. As expected, full-length p53 was not expressed, however low levels of the putative truncated p53 protein were detected by western blotting. Disruption of the functions of Rad50 and p53 may impact the response of PDX models to DNA damaging chemotherapeutics. We observed that chemotherapeutic treatment of the PDX resulted in higher levels of DNA double-strand breaks and increased apoptosis in PIM1-P tumors. Future studies will reveal whether disruption of p53 and/or Rad50 function contributes to the response to chemotherapy observed in these PDX models.

What inspired you to participate in undergraduate research?
I have enjoyed research experiences in the past, and was excited to see what it would be like to experience research on a full-time basis. I have found that research allows me to combine my interest in science with my inquisitive and creative nature.

How did you get your research position, and what preparation did you undertake for it?
The University of Notre Dame has a unique collaboration with MD Anderson, and sponsors Notre Dame students to participate in a 10-week research internship at the MD Anderson Cancer Center. I applied through the MD Anderson Cancer Center-University of Notre Dame Summer Undergraduate Research Program. After being assigned a research mentor, I read papers from the lab I was going to be working in to better understand the field.

Where was your research experience?
The University of Texas MD Anderson Cancer Center. The research facilities are located in the heart of the Texas Medical Center in Houston, Texas.

What did you get out of your research experience?
This opportunity gave me the chance to see what life as a research scientist is really like. I was able to focus on my research, and spend an extended amount of time dedicated to my project over the 10-week period. Looking back, I learned a tremendous amount (about TNBC, science, and even life in general) over those weeks. I also enjoyed getting to know my fellow lab members, shadowing a physician, and attending some amazing lectures.
The accumulation of collagen cross-links in the stroma of tumor cells increases the stiffness of the stroma leading to cancer metastasis. A stiffer tumor microenvironment is created from the overexpression of lysyl hydroxylase 2 (LH2). Mimivirus L230, an analogue of the human LH2 with high sequence identity, was used for experimentation and crystallization because of its relative stability compared to human LH2. The L230 protein purification and crystallization was successful as multiple crystals were collected; however, further purification and refining of the crystallization process are necessary to develop protein crystals with a more solidified three-dimensional shape.

Historically, LH2 activity was measured indirectly by detecting the decarboxylation of 2-oxoglutarate using radioisotopes, which has no high-throughput potential. In order to establish novel assays to study LH2 function in vitro, recombinant hGH-hLH2 protein was expressed as a secreted protein and purified from CHO-S conditioned medium. A novel assay for the detection of LH2 activity was established by the creation of a Succinate Glo HTS assay, which directly measures enzymatic activity by recording luciferase activity. This assay allows for high throughput potential and opens the door for the development of LH2 small molecule inhibitors.

What inspired you to participate in undergraduate research?
I yearned for the opportunity to take my science education to the next level and apply it to living systems in a professional laboratory setting. Having the opportunity to put my knowledge and laboratory course skills to practical use made for an incredible research experience.

How did you get your research position, and what preparation did you undertake for it?
My research position was established thanks to the Notre Dame-MD Anderson Cancer Center Undergraduate Research Internship. This program, which was launched in 2014, paired me with a faculty advisor at MD Anderson Cancer Center in an area of study I was interested in. In order to prepare for this research experience, I read published papers from my lab group about lysyl hydroxylase 2 and learned the fundamentals of the tumor stroma to better understand the role of LH2 in lung cancer metastasis.

Where was your research experience located?
University of Texas MD Anderson Cancer Center, Houston, Texas

What did you get out of your research experience?
This research experience gave me a tremendous appreciation for the work researchers do in the oncology field. I was able to leave this research experience with a better understanding of translational research and its importance in the world of medicine.
Altered Cardiac Electrical Activity in two Different Mouse Models of Sudden Unexpected Death in Epilepsy Involving Mutations in Sodium Channel Genes

Luke McVeigh
Major: Biochemistry
Advisors: Lori L. Isom and Chad R. Frasier, Dept. of Pharmacology,
University of Michigan

Mutations in voltage-gated sodium channel (VGSC) α and β subunits are associated with epileptic encephalopathy (EE). Affected individuals are at increased risk for Sudden Unexpected Death in Epilepsy (SUDEP). A growing body of evidence suggests cardiac arrhythmias resulting from mutant VGSCs expressed in the heart, in addition to brain, may contribute to SUDEP. Using a mouse model of a SCN8A mutation identified in a patient with EE and SUDEP, we found altered cardiac excitability. Ventricular myocytes showed increased action potential duration during the early phases of repolarization. Additionally, we observed an increased incidence of delayed afterdepolarizations and corresponding diastolic calcium release. We next used edge detection software to determine if myocyte contractility was altered in mutant mice. We observed ectopic contractions in the mutant mice (17/20 in mutant vs. 2/21 in WT) with no other physiological differences. In a second model of EE, Scn1b−/− mice, we investigated possible alterations in repolarizing potassium currents in ventricular myocytes. VGSC β1 subunits, encoded by Scn1b, have been shown to interact with Kv4.2 in neurons; however, a similar interaction has not been investigated in heart. Using whole-cell voltage clamp protocols, we studied several potassium currents to ask whether they are altered in Scn1b−/− myocytes. Preliminary results suggest that repolarizing Kv currents are increased in Scn1b−/− myocytes, suggesting a possible increase in Ito, a transient outward current generated by Kv4.2. Future work will test this hypothesis. We conclude that mutations in VGSC genes found in EE patients play critical roles in cardiac, as well as neuronal, excitability.

What inspired you to participate in undergraduate research?
I wanted to finally be able to apply the science I’ve been learning in class over the past couple years and discover how research operates. It’s always great to be able to use what I’ve learned for a good cause.

How did you get your research position, and what preparation did you undertake for it?
I was interested in a research position for the summer so I simply looked up various summer programs and fellowships at universities I would be interested in. I found the University of Michigan Frankel Cardiovascular Summer Fellowship and it was a great fit for me. I applied for the fellowship and it provided the funding for my summer research.

Where was your research experience located?
University of Michigan, Ann Arbor, MI

What did you get out of your research experience?
My summer research provided me with a great summer in Ann Arbor! This was my first experience in a research lab so I learned a lot including the basics of conducting research, collaborating with others, analyzing data, and publishing results. I really enjoyed my time with my lab mentor and other lab members. It was a very productive summer that will prepare me well for future lab work.
Superconducting Properties of SrRuO$_4$ Analyzed Through Small Angle Neutron Scattering

William Morgenlander
Major: Physics
Advisor: Morten R. Eskildsen, Dept. of Physics, University of Notre Dame

The superconducting state arises from the formation and condensation of Cooper pairs, but the exact coupling mechanism in many materials remains unknown. Microscopic understanding of these unconventional superconducting states is closely tied to comprehension of the superconducting order parameter. There is both experimental and theoretical evidence for the existence of triplet pairing and p-wave symmetry in the order parameter of the superconducting state in SrRuO$_4$ (SRO) which makes SRO a quintessential model for spin triplet pairing states and unconventional superconductivity in general. Although it has been extensively studied, the exact nature of the superconducting order parameter in SRO has not yet been determined. The Eskildsen Group specializes in the study of unconventional superconductivity through analysis of the Vortex Lattice (VL) that arises in unconventional superconductors like SRO. We use Small Angle Neutron Scattering (SANS) to determine bulk properties of the VL which in turn provide information about the nature of the host material’s order parameter. The group has placed constraints on possible order parameters in SRO through SANS experiments, and provides an experimental framework for future theories.

What inspired you to participate in undergraduate research?
“Physics is a dynamic and constantly changing subject, and I wanted to experience it outside of the classroom. Additionally, I desired more technical experience relevant to my future studies.”

How did you get your research position, and what preparation did you undertake for it?
“I joined the Eskildsen Group in November of 2014. My duties previously included analysis of past experimental data and learning about phenomena studied by the group. In order to build on the work that I started during the year, I wrote a grant for summer research that was funded by the Glynn Family Honors Program.”

Where was your research experience located?
“My research was conducted both at Notre Dame and at the Institut Laue-Langevin in Grenoble, France.”

What did you get out of your research experience?
My work with the Eskildsen Group has taught me about condensed matter physics phenomena that can be described well and also phenomena that are still under scrutiny. Additionally, I gained a variety of technical skills and experience including real time data analysis, control over the SANS equipment, and international collaboration. My time in the lab was unpatrolled exposure to the real world of experimental physics.”
Microtubules (MTs) are filamentous structures essential for cell processes like intracellular transport and chromosome segregation during mitosis; multiple diseases are caused by their dysfunction. Changes in the organization of MTs allow them to complete these processes, so we need to better understand the regulation of MT organization in order to treat these diseases.

Microtubule organization is produced by structure: MTs are long tube-like polymers made up of protein subunits called tubulin. Tubulin subunits can attach noncovalently to the end of an MT to grow the filament (polymerize), or detach to shorten it (depolymerize). We focused on two unique behaviors related to MT polymerization, termed dynamic instability and treadmilling. Dynamic instability refers to the ability of MTs to switch between phases of growth and shortening. Treadmilling is a process that relies on MTs having two free ends. While treadmilling, MTs move through the cell by means of net gain of tubulin subunits on one end, and net loss of subunits from the other. To better understand these two different dynamics, we used computational modeling to clarify the relationship between these behaviors and the polymerization of tubulin subunits, specifically by determining the tubulin concentrations at which each behavior exists.

**What inspired you to participate in undergraduate research?**

“I love finding out how the world works, whether the answers come in a lecture class, or my own research. Research is a lot more work, but the process is worth it because unlike in lecture, no one knows the right answers – or questions. You get to ask your own questions, figure how to answer them, and then piece together entirely new information about the world.

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

“I submitted a proposal to the College of Science Summer Undergraduate Research Fellowship, and the Glynn Family provided funding for my project. I was prepared for the position because I have done academic-year research in the Goodson lab since my sophomore year.

**Where was your research experience located?**

“University of Notre Dame”

**What did you get out of your research experience?**

“A chance to see whether I might enjoy grad school (and it looks like I will!). I also made significant progress on my project, learned new programming skills, and soaked up a summer on campus.”
Immortalization of human skeletal muscle cells

Joseph Ong
Major: Chemistry
Advisor: Shyh-Chang Ng, Junior Investigator, Genome Institute of Singapore
Coauthors: Elwin Tan

Immortalization of muscle cells is a feat which has been accomplished in mouse muscles but not in human muscles. The development of an immortalized muscle cell line will not only allow us to develop better models of human muscles for research, but will also help unravel what factors affect age-related differentiation and senescence in other tissue types for the purposes of combating aging-associated degeneration and diseases. To this end, three cell lines were established, one with suppression of p14ARF, one with suppression of RB1, and one with suppression of both. Previous work (Pajcini, et al. Cell Stem Cell, 2010) demonstrated that suppressing these two genes was able to de-differentiate mouse muscle. On the basis of this work, we examined whether suppressing these same genes would either cause de-differentiation or result in gene expression patterns that would extend the proliferative capability of human myoblasts. Ultimately, our observations suggest that suppression of these genes does not seem to support proliferation of myoblasts, and qPCR data shows that the myogenic gene expression of these cell lines are somewhat dissimilar from wild-type hSKM cells, unlike what was previously shown in mouse cells. This highlights the vast differences between mouse and human tissues.

What inspired you to participate in undergraduate research?
I wanted to participate in undergraduate research because I’m interested in learning how the world works and understanding the complex and dynamic relationships between chemical and biological systems, whether that means understanding why or how a reaction proceeds, or discovering what factors regulate and govern the inner workings of a cell.

How did you get your research position, and what preparation did you undertake for it?
I studied abroad in Singapore at NUS for the Spring 2015 semester. An academic connection from summer of 2014 introduced me to Dr. Ng and I started my work in the Ng lab in January during the academic semester and continued my work under a SIPGA grant in the summer.

Where was your research experience located?
Genome Institute of Singapore, a research institution under A*STAR in Singapore.

What did you get out of your research experience?
Besides having the chance to live and work another country, I learned how to work with tissue culture and many fundamental techniques in molecular and cell biology like qPCR and Western Blotting.
**Hepatic Differentiation of Induced Pluripotent Stem Cells (iPSCs) in a Transwell Culture System**

Kieran Phelan  
Major: Biological Sciences  
Advisor: Jorge Bezerra  
University of Cincinnati College of Medicine and Cincinnati Children’s Hospital Medical Center, Division of Gastroenterology  
Coauthors: Akihiro Asai, Pranav Shivakumar, Jorge Bezerra

iPSCs are unique in their ability to differentiate into adult somatic cells, allowing development of patient-specific disease models and the recapitulation of disease phenotypes where animal models are insufficient. We aimed to create a system to differentiate iPSCs into hepatocytes in vitro utilizing transwell culture plates. iPSCs were placed in the upper chamber of the plate, and the lower chamber consisted of one of three culturing environments: human umbilical vein endothelial cells (HUVECs), mesenchymal stem cells (MSCs), or a co-culture of the two cell types. iPSCs were cultured in these environments for 8 and 12 day periods, and were tested for hepatic protein markers using immunofluorescence, immunohistochemistry, and quantitative polymerase chain reaction (qPCR) analysis. All environments produced cells which expressed differentiated protein markers, demonstrating the presence of viable hepatocytes within our culture system. We also found the co-culture produced larger amounts of bile-salt transporter proteins when compared to other environments. These data suggest soluble factors from MSCs and HUVECs promote the differentiation of iPSCs into viable hepatocytes. Also, MSC and HUVEC cultures appeared to differentiate iPSCs to a similar extent, whereas the co-culture influenced iPSCs to a distinct sub-type of hepatocytes.

**What inspired you to participate in undergraduate research?**  
I have a passion for scientific discovery and a desire to help better the lives of those around me. I have found that doing research within a laboratory is an excellent way to fulfill both of these goals.

**How did you get your research position, and what preparation did you undertake for it?**  
Luckily for me, Dr. Bezerra was a neighbor of mine, and he agreed to help me get started within the field of biomedical research. What started out as a trial in a lab setting turned into a summer job, and I am fortunate to have landed in an incredibly supporting environment for my first research experience.

**Where was your research experience located?**  
Cincinnati Children’s Hospital Medical Center and the University of Cincinnati College of Medicine

**What did you get out of your research experience?**  
An exciting summer pioneering the field of stem cell research. I also got to experience all aspects of life in a lab and life in a medical setting. I will never forget the great friends I made, both with those in my lab and those who were part of the same undergraduate program as I was.
Effectiveness of the Aortic Dissection Detection (ADD) Risk Score in Diagnosing Low-Risk Patients

Anna Poteraj
Major: Biological Sciences
Advisor: Kim A. Eagle and Elise Woznicki, Michigan Clinical Outcomes Research and Reporting Program, University of Michigan Health System

The aortic dissection detection (ADD) risk score guidelines released in 2010 by the AHA and ACC proposed 12 clinical risk markers to identify patients with aortic dissection. The ADD score ranges from 0 to 3 and is based on the number of risk categories under which a patient’s symptoms or conditions fall. The ADD risk score has been shown to be highly sensitive in detecting aortic dissection in those with a score of 1 or greater, but not for those with an ADD score of 0. Patients from the IRAD (International Registry of Acute Aortic Dissection) database from 1996 to 2015 were divided into two groups: those who did not present with any of the 12 clinical risk markers comprising the ADD risk score (ADD score = 0) and those presenting with at least one of these clinical risk markers (ADD score ≥ 1). These two groups were compared in terms of demographics, predisposing conditions, and presenting symptoms not included in the ADD risk score. There were seven different symptoms and conditions at which patients in the ADD score = 0 group presented at significantly higher rates than the ADD score ≥ 1. Further characterization of ADD score = 0 patients may foster the elucidation of better strategies to detect aortic dissection.

What inspired you to participate in undergraduate research?
“I know that I want to be a physician in the future and wanted to get a better idea of some of the kinds of clinical research that physicians participate in.”

How did you get your research position, and what preparation did you undertake for it?
“I discovered this opportunity after extensive internet searches for summer research positions that I thought I would be interested in, and submitted my resume and a statement of interest to the contact person. This position was part of an internship at the Michigan Clinical Outcomes Research and Reporting Program (MCORRP) which involved attending lectures and undergoing a lot of training before formulating and completing our own research projects.”

Where was your research experience located?
“University of Michigan Health System”

What did you get out of your research experience?
“I learned so many new things about cardiovascular medicine and outcomes research. It was a wonderful summer working in a new place with new people in what I discovered to be an incredibly collaborative environment. This opportunity made it apparent to me that a small group of people with big ideas has the potential to be truly impactful.”
Platelet Counts and Their Effect on Patient Outcomes with Patent Ductus Arteriosus (PDA)

Edel Sah
Major: Biology and ACMS
Advisor: Patrick Breheny, Dept. of Biostatistics, University of Iowa
Coauthors: Lorena Cristal, Chelsea Robalino

As a fetus develops, blood passes from the heart through an open aorta to the not yet functional lungs. Once the baby has been delivered, it is expected that the heart closes off the aorta from the pulmonary artery, separating the oxygenated and deoxygenated blood. Sometimes this does not occur, causing a circulatory disorder called patent ductus arteriosus (PDA). This research focuses on premature newborns, who have a higher prevalence of this disorder. Currently, it is unclear to doctors what is the best approach to treating PDA: letting the aorta close on its own, administering medicine (indomethacin), or performing surgery.

Data for 405 preterm newborns was collected at the University of Iowa Hospitals and Clinics. We used logistic regression to examine the relationship between platelet counts in the first 7 days of life and other factors on three clinical outcomes: development of PDA, recovery without intervention, and successful indomethacin treatment. We found a positive correlation between higher platelet counts and better clinical outcomes for the patients. There were interesting dynamics between the early, later, and average platelet counts and their importance in our predictive models.

What inspired you to participate in undergraduate research?
“I like the process of asking questions and applying our knowledge to answer those questions, and I think that undergraduate research is a great way of doing so. As a Biology and ACMS double major, I really wanted to get involved in a research setting related to biostatistics, which has strong links to both fields.”

How did you get your research position, and what preparation did you undertake for it?
“After learning about the Summer Institute for Training in Biostatistics, I went through the application process. After submitting my application, the institute provided me a position for the summer.”

Where was your research experience located?
“University of Iowa”

What did you get out of your research experience?
“A great summer at Iowa City, friends, and experience in biostatistics. I also learned a lot about how biostatisticians collaborate with other researchers to produce exciting results.”
The pathologic immune response to Pneumocystis is dependent on CD4+ T cells and IL-25

Katelin Serody
Major: Science Pre-professional and Psychology
Advisor: Jay Kolls, Director,
Richard King Mellon Foundation Institute for Pediatric Research, and
Taylor Eddens, University of Pittsburgh School of Medicine
Coauthors: Taylors Eddens, Jay Kolls

Pneumocystis jirovecii is an opportunistic fungus that affects both the HIV-positive population and the immunosuppressed HIV-negative population. In order to gain a better understanding of the immune response induced by Pneumocystis, we compared and contrasted the immune response to Pneumocystis antigen (PC Ag) with the response to house dust mite (HDM), a common airway allergen, specifically focusing on differences in early cytokine release. Using a murine model of Pneumocystis infection, it was found Pneumocystis induces a Th2 response that is dependent on CD4+ T cells. IL17RB-/- mice used in the PC Ag murine model showed that mucus, eosinophil recruitment, and release of IL-33 are dependent on IL-25 in response to PC Ag but not in response to HDM. To look at the early response to Pneumocystis in human cells, HBE cells were cultured and treated with HDM and PC Ag. IL25 and IL33 were mildly upregulated in human cells in response to PC Ag. Previous clinical data shows worse symptoms in severe asthma patients with high PC antibody titers. As the results of this study suggest an important role of CD4+ T cells and IL-25 in the pathologic response to PC Ag, IL-25 should be a cytokine of important focus for looking at PC high severe asthma patients in the future.

What inspired you to participate in undergraduate research?
I want to be a doctor one day, and I think research is a great way to learn about and be on the forefront of the medical field. I also really enjoy the process of asking questions, designing experiments to answer them, and learning to interpret results. Research is fascinating because it gives you the opportunity to learn about and discover something previously unknown.

How did you get your research position, and what preparation did you undertake for it?
I applied for the Summer Research Internship at Children’s Hospital of Pittsburgh via their online application. This was my second year doing this internship, but I was assigned to a new lab. To prepare for my research experience, I read a few of the papers written by my mentor to gain a general understanding of his research interests. Once I started my internship and was assigned to my specific project, I prepared by reading a lot of different papers that specifically dealt with Pneumocystis and asthma. I also was able to get up to speed by asking lots of questions.

Where was your research experience located?
Children’s Hospital of Pittsburgh

What did you get out of your research experience?
Besides improving my basic science lab skills (pipetting!) and learning a lot about Pneumocystis and asthma, the biggest take away I got from my summer research experience was learning how to think critically about data, even when it may be different than what was expected from an experiment, and to brainstorm future directions of research and ideas for new experiments. This summer, I learned how to best frame a research “story.” Additionally, I got excellent practice with making and presenting scientific posters, and I even was a co-author on a recently submitted paper. Besides that, I met a lot of incredibly gifted and amazing people that I was so lucky to work with!
Skeletal muscle and bone tissues contain an intrinsic vascular supply that is essential for proper maintenance of vital tissue functions. Spaceflight experience has established that hypogravity induces skeletal muscle atrophy in the legs, and that this sarcopenia is associated with atrophy of the muscles’ vascular supply. Thus it has also been suggested that hypogravity may induce some vascular degeneration and/or regression thereby contributing to sarcopenia and osteopenia. Hind limb tissue of female C57BL/6C mice flown aboard NASA’s final space shuttle mission, STS-135, and a ground-based control group, were analyzed via qRT-PCR and histological image processing. Expression of genes associated with endothelial cell permissibility and vessel tone, angiogenesis, activation, and cell injury were carried out via qRT-PCR. Blood vessel morphology was studied by processing immunofluorescent histological tissue section images using macros specifically developed to quantify vessel size, vessel number, and other parameters in particular regions of interest throughout the tissue. These analyses are ongoing and not yet completed. Nevertheless, data reveal alterations in vascular remodeling in spaceflight versus ground control mice. It is anticipated that such vascular alterations will likely impact bone health, particularly astronaut fracture healing responses in space.

What inspired you to participate in undergraduate research?
My deep love of learning and commitment to using my gifts to serve others draws me to research. I am motivated by the thought that the knowledge I am helping to generate may assist NASA physicians in keeping future astronauts healthy. As an aspiring physician I also seek to gain an understanding of the scientific research process and community so that I will be capable of keeping up with the evolving state of medical knowledge and treatments.

How did you get your research position, and what preparation did you undertake for it?
I initially became involved with the lab in Spring 2014 when I emailed the Midura Lab expressing interest in their research after reading Dr. Midura’s profile on the Cleveland Clinic Lerner Research Institute website and was offered a volunteer position for the summer. After volunteering during Summer 2014, I was invited back as a paid undergraduate research assistant. I would encourage students looking for research opportunities to seek out research that genuinely interests them; if you’re passionate about the topic it can make what might be tedious work truly meaningful and exciting.

Where was your research experience located?
Cleveland Clinic Lerner Research Institute, Cleveland, Ohio

What did you get out of your research experience?
I was lucky to have a myriad of experiences that helped grow my technical and interpersonal skills. On the technical side, I gained problem-solving skills as I refined an Image Pro image processing protocol I developed the summer before, prepared collagen gels, and gathered data using x-ray and microscopy techniques. Personally, I became a better communicator and scientist as I managed two other students in the lab, participated in lab meetings, practiced effective time management, and was a recipient of the mentorship of the lab staff and older students.
Cognitive Dysfunction Partially Mediates the Association between Sleep Duration and Functional Status

Harisa Spahic
Major: Biochemistry
Advisor: Pascal Jean-Pierre, Dept. of Psychology, University of Notre Dame
Coauthors: Sara Hockney, William Kim, Keith Mesidor, Ashley Murphy

Purpose: Cognition, functional status, and sleep have not been analyzed together in a representative US population despite the magnitude of cognitive impairment present in the population and research analyzing those three individually.

Methods: NHANES data from 2007-2008 of the US non-institutionalized population was used to test the relationship between sleep duration and functional status and whether cognitive dysfunction mediated that relationship. Sleep duration was measured as very short (<5 hours), short (5-6 hours), normal (7-8 hours), and long (>8 hours). Functional status was assessed through 22 measures of daily activity. Cognitive dysfunction was assessed as self-reported memory difficulties. Three logistic regression models predicted likelihood to report functional status limitations according to sleep duration where normal sleep was the reference. Analysis was adjusted for covariates and cognitive dysfunction. The Sobel-Goodman test was run to analyze mediation.

Results: Very short sleep was significantly associated with 11 measures of functional status, short sleep with 4 measures of functional status, and long sleep with 2 measures of functional status. Mediation was only partial with ranges from 9-13% for ability and amount able to work and 1-5% for other measures.

Conclusion: Cognitive dysfunction partially mediates the relationship between sleep and functional status.

What inspired you to participate in undergraduate research?
I really enjoy the lectures within my class however a lot of the topics are not explicitly related back to the real world where they can be applied. I wanted to done undergraduate research so that I could apply the things I learned in class to a problem outside the classroom.

How did you get your research position, and what preparation did you undertake for it?
I started work in the Cancer Neurocognitive Translational Research Lab (CNTRL) in Summer 2014 immediately after graduating high school. I was notified of the opportunity to work in a research lab on Notre Dame’s campus for 2-4 weeks in the summer and jumped at the chance to do so. Following my month in the lab, I was asked to stay as I started school at Notre Dame which I happily accepted. This past summer, I was fortunate enough to be awarded the Eagan Fellowship from the Center of Undergraduate Scholarly Engagement (CUSE) which was used to fund my primary research project over the summer; however, I worked on the research currently being presented at the same time.

Where was your research experience located?
University of Notre Dame

What did you get out of your research experience?
I learned how intricate the process of writing a paper is. I also learned how to work in a group when writing a paper. Since this was only one part of my summer research, I also learned how to work on multiple projects during one period of time.
Isolation of Antimicrobial Compounds from Red Oak (Quercus rubra L.) Acorns

Robert Stanley
Major: Biochemistry
Advisors: Jeanne Romero-Severson, Shaun Lee, Dept. of Biological Sciences, and Viktor Krchnak, Dept. of Chemistry and Biochemistry, University of Notre Dame
Coauthors: Clayton Thomas

Every year over 75,000 people become infected with Methicillin-resistant Staphylococcus aureus (MRSA) in the US alone. These bacterial infections are resistant to most current antibiotics, and are developing resistance to others faster than new antibiotics are produced. This loss of viable antibiotics has caused researchers to revisit traditional sources of antimicrobial compounds; plants, animals and fungi. This research project is focused on investigating new antimicrobial compounds from the acorns of the northern red oak (Quercus rubra L.). Extracts of powdered acorns in water, ethanol, and ethyl acetate have all demonstrated activity against a variety of bacteria including MRSA and streptococcus sp. The ethyl acetate extract possessed the most activity, and was partially purified through Column Chromatography. Three separate fractions contain activity and are being further purified through High Pressure Liquid Chromatography (HPLC) separations. These fractions will be tested for antimicrobial activity, and the most active portions will be further purified. Analytical data was recorded through Liquid Chromatography Mass Spectroscopy (LCMS) and Nuclear Magnetic Resonance (NMR). Multiple fractions of the Ethyl Acetate extract have shown strong inhibition of MRSA implying that there are multiple antimicrobial compounds. Future work will focus on isolating the active compounds and devising a method of synthesis.

What inspired you to participate in undergraduate research?
I always wanted to “do science” to actually participate in real research and discover things that no one has ever known. Also my professor is awesome, and after meeting her, I wanted to be part of her lab.

How did you get your research position, and what preparation did you undertake for it?
I have been a member of the Romero-Severson lab since the spring of 2013. I emailed my professor after meeting her at the undergraduate research networking dinner. After working for a year assisting graduate students with genetics work, my professor and I brainstormed potential biochemistry projects and we came up with my current project.

Where was your research experience located?
“University of Notre Dame”

What did you get out of your research experience?
I had an awesome time at Notre Dame during the summer; it was very productive to be able to just focus on research without classes or TAing at the same time. I was able to conduct interdisciplinary research, gain valuable research experience, and learn many new techniques. My research experience this summer provided a solid basis for my future in research and graduate studies.
Over 90% of cancer-associated deaths are caused by metastasis. In order for metastasis to occur, cancer cells at the primary site must pass through multiple steps before they can develop into a secondary tumor at a distant site. An embryonic developmental program called epithelial-to-mesenchymal transition (EMT) has been shown to be activated during cancer invasion and metastasis. When EMT is induced in epithelial cells, they lose their epithelial morphology and gain mesenchymal properties. Adhesion molecules that facilitate cell-cell adhesion and cell-matrix interaction, such as E-cadherin and integrins respectively, are repressed. This results in a loss of cell-cell adhesion, an increase in cell motility, and acquisition of invasive properties. Additionally, induction of EMT promotes stem cell properties in epithelial cells. Thus, targeting and inhibiting EMT in cancer cells may provide novel methods of inhibiting and treating metastatic cancers. This poster shows that SUM159 human breast cancer cells display a more mesenchymal phenotype when compared to MCF-7 breast cancer cells, which are known to express a more epithelial phenotype.

What inspired you to participate in undergraduate research?
I was interested in learning more about the processes and methods of research. Additionally, the opportunity to learn at a top cancer research institute like MD Anderson was impossible to turn down.

How did you get your research position, and what preparation did you undertake for it?
I applied for an undergraduate research opportunity at MD Anderson Cancer Center through Notre Dame and I was able to secure a position in a 10-week program funded by Notre Dame.

Where was your research experience located?
MD Anderson Cancer Center

What did you get out of your research experience?
I learned much about the biology of breast cancer cells and how EMT affects breast cancer metastasis. Additionally, the summer taught me many different and important biology lab techniques and how I could use these techniques to prepare my own experiments.
Infections by multiple genetically distinct *Plasmodium falciparum* parasites are common in cases of malaria. The dynamics of mixed infections causes competitions that select for parasites with fitness advantages. With slower clearance rates to artemisinin treatment, it is essential to understand the fitness of parasites with delayed clearance phenotypes that could influence their spread. In this study, sets of genotypically distinct parasites were co-cultured, and fragment analysis was performed on DNA samples collected periodically to determine the relative densities of each strain in culture. NF54HT-GFP–luc (NF54) was competed against two parasite clones (NHP♯ and NHP*) recently isolated from Southeast Asia that showed delayed parasite clearance. NHP♯ has a mutation in the K13 propeller domain (C580Y), while NHP* does not. The competition between NF54 and NHP♯ initially favors NF54; however, after 35 days NHP♯ is favored and this continues until NHP♯ outgrows NF54. NHP* outcompeted NF54 within 21 days, and NHP* outcompeted NHP♯ within 23 days. This provides insights into fitness costs and advantages of K13 propeller domain mutations. Future experiments involving competitions with a non-transfected NF54 strain will display the fitness advantages of these isolates. Further examination of competitive growth will enhance knowledge of how parasite interactions within mixed infections can influence the spread of resistant parasites.

*What inspired you to participate in undergraduate research?*

“I wanted to expand my knowledge of biology outside of the classroom and become actively involved in studying infectious disease while I’m still an undergraduate.”

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

“I joined the Ferdig lab in the fall of 2014 after taking a course with Dr. Ferdig and learning about his research. I began working on this specific project on my own in the spring of 2015 and spent the summer at Notre Dame with funding from the College of Science and the Glynn Honors Program. I will be continuing this project for my thesis for the rest of my time here.”

*Where was your research experience located?*

“University of Notre Dame”

*What did you get out of your research experience?*

“The research I have completed so far have given me far more skills in research and the sciences in general than I had expected. I now know that I want my future plans be research oriented. My project has also given me the opportunity to present at the American Society of Tropical Medicine and Hygiene national conference!”
Investigation of the role of ΔNp63 in tracheal basal stem cells in vitro

Jessica Trinkl
Major: Science-Business, Spanish
Advisor: Elsa R. Flores, Dept. of Biochemistry & Molecular Biology, MD Anderson Cancer Center
Coauthor: Sarah J. Wu

The lung is maintained by a unique set of regional stem cell populations. Basal stem cells are responsible for establishing the tracheal epithelium by differentiating into ciliated and goblet cells. Basal stem cells express the transcription factor p63, which is comprised of two groups of isoforms, ΔNp63 and TAp63, and whose roles in basal stem cell biology and tumorigenesis are not well understood. In this study we show that ΔNp63 is necessary for maintaining normal functioning of basal stem cells. Using a ΔNp63 conditional knockout mouse model, we have isolated and grown tracheal mouse basal stem cells in vitro and assessed the spheres for size, number and expression of markers using immunohistochemistry. We found that loss of ΔNp63 results in decreased basal cell sphere size, as well as altered proliferation and differentiation activities. As it is hypothesized that cancer originates from transformed stem cells, we believe that ΔNp63 is critical for basal stem cell fate and may impact the formation of lung squamous cell carcinoma.

What inspired you to participate in undergraduate research?
“I believe that in biology classes at Notre Dame we get a firm understanding of what is known in the scientific world, but we often miss out on understanding the complexity and struggles in the process of that knowledge attainment. Research offers me an opportunity to work between the known and unknown, and has given me a greater appreciation for our current scientific knowledge as well as how much we still have to discover.”

How did you get your research position, and what preparation did you undertake for it?
“I applied to the Joint Notre Dame-MD Anderson Summer Research Experience Program which made this experience a possibility. Prior to researching at MD Anderson, I had worked in a Clinical and Translational Research Unit at the Medical College of Wisconsin.

Where was your research experience located?
“MD Anderson Cancer Center in Houston, Texas”

What did you get out of your research experience?
“I learned an incredible amount about different molecular biology techniques via hands-on experience, as well as gained a fuller understanding of the entire research process. Outside of the laboratory, I was able to shadow leading doctors in their respective fields. Overall, I made many new friends and connections that will serve as a foundation for my career in medicine.”
Decitabine drives the concurrent induction of Maelstrom and PIWIL2 in acute myeloid leukemia cells

Diego Valenzuela
Majors: Science Professional Studies & Theology
Advisor: David W. Lee, University of Arizona, Ronald A. Matricaria Institute of Molecular Medicine at Phoenix Children’s Hospital
Coauthors: David W. Lee and Robert J. Arceci

Decitabine (DAC) is a FDA-approved hypomethylating agent used in pediatric acute myeloid leukemia (AML) treatment. DAC incorporates into newly synthesized DNA and disrupts DNA methylation. Studies of the AML cell line Molm13 show a concurrent induction of Maelstrom (MAEL) and PIWIL2 genes following DAC exposure. MAEL and PIWIL2’s mRNA’s upregulation mechanism via DAC remains undetermined; our focus was determining MAEL and PIWIL2’s roles. Molm13 cells (non-transfected or transfected with MAEL or PIWIL2 shRNAs) were treated with DAC over five days. RNA, DNA, and protein were collected for analysis. HEK293A, normal human kidney, cells transfected with a MAEL expression vector, did not show increased PIWIL2 expression suggesting MAEL does not drive PIWIL2. Analysis of bisulfite conversion for MAEL’s promoter proved inconclusive. QPCR analysis of mRNA expression revealed increased MAEL and PIWIL2 message in the non-shRNA transfected Molm13 cells and corresponding message reduction in shRNA transfected cells. Western blot analysis with MAEL antibodies reflected the qPCR results, indicating an increase in MAEL protein in the non-shRNA transfected Molm13 cells while displaying a delayed decrease in MAEL protein levels in shRNA transfected cells. This suggests that MAEL and PIWIL2 are DNA repair genes or oncogenes because of decreasing expression and increasing cell viabilities.

What inspired you to participate in undergraduate research?
“I was eager to understand what molecular biology research was all about. Additionally, I like asking questions and then having the opportunity to answer these questions in a lab setting.”

How did you get your research position, and what preparation did you undertake for it?
“I applied for the Helios Education Foundation Summer Scholars internship in January of 2015, and I was accepted for a position in the Arceci lab in April. This granted me the opportunity to go home during the summer to perform research at a world-class institution, something that I could not pass up. I prepared by reviewing relevant concepts that I had previously learned in courses such as microbiology and cell biology, and subsequently, I contacted my mentors prior to the start of the internship and asked them for specific papers to read.”

Where was your research experience located?
“Translational Genomics Research Institute (TGen), in Phoenix, Arizona.”

What did you get out of your research experience?
“During my experience, I gained a newfound respect for researchers and for their tireless efforts to aid others. It was definitely a humbling experience, but I gained many new friends, and I enjoyed my time in the lab. I would recommend this internship to anyone from the state of Arizona, for whom the internship only applies.”
The Prevalence of Lyme disease in Northern Indiana

Charday Ward
Major: Chemistry
Advisor: Holly Goodson, Dept. of Chemistry and Biochemistry, University of Notre Dame

Lyme disease has become the most common vector-borne disease in the United States. While it produces flu-like symptoms in the early stages of the disease, nerve problems and arthritis may present itself in the more advance stages. Lyme disease is most often transmitted through the bite of a deer tick, Ixodes scapularis, infected with the bacteria Borrelia burgdorferi. A large population of this species can be found in the Northeastern region of the country, however there has recently been a large increase of I. scapularis found in the Midwest. To investigate the presence of B. burgdorferi infected ticks in Northern Indiana, total DNA was extracted from ticks collected at a site in St. Joseph County. The extracted DNA was used in a set of two PCR reactions designed to probe for the presence of (1) tick genomic DNA (this was a control to confirm that the extraction worked) and (2) to the B. burgdorferi bacteria that causes Lyme disease. Agrose gel analysis of the resulting PCR products will be used to determine the presence of B. burgdorferi in the samples. By obtaining information about the prevalence of B. burgdorferi infected ticks in Northern Indiana, adequate precautionary measures can be taken to decrease the spread of Lyme disease.

What inspired you to participate in undergraduate research?
I’ve always enjoyed the labs that accompanied the lectures for my chemistry classes so I was interested in exploring undergraduate research.

How did you get your research position, and what preparation did you undertake for it?
Dr. Goodson has been my mentor since the fall of my freshman year in 2013. After expressing to her my interest to pursue a career in forensics or criminology, she helped me begin my analytical research in the spring of 2014.

Where was your research experience located?
University of Notre Dame

What did you get out of your research experience?
Throughout my research I’ve been able to work closely with my peers, which has exposed me to a variety of research projects that are currently being conducted here at Notre Dame. I’ve also learned a number of new lab techniques.
Developing tools for homology-independent CRISPR/Cas9 mediated integration of a reporter cassette in zebrafish

Kevin Wilkins
Major: Biological Sciences
Advisor: David Hyde, Dept. of Biological Sciences, University of Notre Dame
Coauthors: Ryne Gorsuch

The latest technology in the field of genome editing is the clustered regularly interspaced short palindromic repeats (CRISPR) system that consists of CRISPR-associated protein 9 (Cas9) and a chimeric small guide RNA (sgRNA). The sgRNA basepairs with the complementary genomic DNA sequence at the targeted genomic locus and recruits Cas9, which induces a double strand break (DSB) in the DNA. The cell can repair this break via non-homologous end joining (NHEJ), an error prone mechanism that creates either insertion or deletion mutations at the cleavage site or the DSBs can be used to integrate foreign DNA into the genome. This study describes the preliminary work to create knock-in reporters using NHEJ. In order to design a proof-of-principal experiment, we needed to identify a functional sgRNA for an endogenous gene. We designed a sgRNA targeting the sox2 open reading frame. When compared to uninjected control fish, the majority of the sox2 sgRNA injected fish exhibited a phenotype ranging from wild type to mild and severe developmental defects, suggesting the sox2 gene was disrupted. T7E1 assays showed the DSBs were induced at the expected target site, which was confirmed via DNA sequencing. Future work will involve injecting this sox2 sgRNA with a donor plasmid harboring the sox2 sgRNA target site and the fluorescent reporter gene tdTomato to generate a Tg(sox2:tdTomato) transgenic reporter line.

What inspired you to participate in undergraduate research?
“...I am fascinated with biology and cutting edge biological tools. In particulars, I believe that genomic editing will be a major component of future medicine. I wanted to learn more about how our bodies work and try to make a contribution to the field”

How did you get your research position, and what preparation did you undertake for it?
“...I have been in the Hyde lab since Fall 2014, where I learned basic and advanced lab techniques. In order to continue my research over the summer, I applied and received the Notre Dame Research Experience for Undergraduates (REU).”

Where was your research experience located?
“University of Notre Dame”

What did you get out of your research experience?
“...I really understood what it means to be in a research lab full-time and this helped me discern my career choice. Additionally, I got to learn many new techniques, improved my research and paper reading skills, and got to work on my own project. Finally, I met a lot of great people and spent an amazing summer on campus!”
Does a domain-general sequence learning ability support language development?

Katherine Wolfert
Major: Neuroscience & Behavior
Advisor: Jill Lany, Dept. of Psychology, University of Notre Dame

Infants learn to recognize visual and auditory patterns around the same time they begin to develop language skills. The ability to learn predictable visual sequences has been linked to vocabulary outcomes at 6-8 months, and auditory statistical learning is thought to support word-segmentation and learning word-order patterns. At this age, the ability to imitate actions after a delay is also connected to language outcomes. It’s possible that two distinct processes may underlie language development: implicit sequence-learning and explicit learning and memory. If so, performance on visual and auditory learning tasks should predict common variance in language outcomes, but be unrelated to deferred imitation. This study found that in 8-month-old infants, reaction time on a visual sequence-learning task was correlated to the number of gestures comprehended. Auditory statistical learning and deferred imitation measures were unrelated to any of the other tasks, indicating that these measures might be insufficiently sensitive at this age. The connection between visual sequence learning and gestural comprehension is promising, and indicates that this type of learning may contribute independently to language development. Future research should continue to investigate early predictors of language outcomes and their interrelationships, as they could shed light on sources of language-learning difficulties.

What inspired you to participate in undergraduate research?
“I love working with little kids, and I’m fascinated by how this type of research attempts to answer questions about how they grow and develop.”

How did you get your research position, and what preparation did you undertake for it?
“This is my fifth semester as a research assistant in Dr. Lany’s Infant Studies Lab, so I was very excited to finally have the opportunity to develop a project of my own. My research was funded by a Comprehensive Summer grant from the Institute for Scholarship in the Liberal Arts here at Notre Dame.”

Where was your research experience located?
“University of Notre Dame”

What did you get out of your research experience?
“One of the most important skills I learned is how to design a study; I didn’t realize how many details go into the planning and development stages! I also enjoyed interacting with the participants and my lab group.”
Production and biological evaluation of the polyketide naphthocyclinone from the bacteria *Streptomyces arenae*

Emily Zion  
Major: Biochemistry  
Advisor: Richard Taylor, Dept. of Chemistry and Biochemistry, University of Notre Dame  
Coauthors: Eve Granatosky

Natural products have been valued for their medicinal qualities for thousands of years and have helped to form the basis of modern medicine. The term natural product is used to encompass a wide range of compounds that are derived from natural sources. The polyketide class of natural products includes many diverse secondary metabolites produced by organisms for a survival advantage. Naphthocyclinone, one natural product produced by the bacteria *Streptomyces arenae*, is a type II, aromatic polyketide that possesses antibacterial properties. In particular, naphthocyclinone belongs to the isochromane quinone family of antibiotics. The full therapeutic potential of naphthocyclinone, however, is not completely understood. In order to delve deeper into this potential drug source, we plan to extract naphthocyclinone from *Streptomyces arenae* and complete a full chemical characterization. Efforts will be placed into increasing the production of the natural product through engineering of the growth media. Another aspect of this project will focus on identifying analogues of naphthocyclinone produced by *S. arenae* under different growth conditions. Further research will go into investigating the therapeutic properties of naphthocyclinone. This investigation of naphthocyclinone could lead to beneficial uses for the natural product, and will contribute to the field of research of natural products.

**What inspired you to participate in undergraduate research?**  
“Being in a laboratory setting makes me love what I study even more. I am able to apply what I’ve learned in class to something undiscovered.”

**How did you get your research position, and what preparation did you undertake for it?**  
“I have worked in the Taylor laboratory for a little over a year now after expressing my interest in the Taylor lab. For preparation, I always make sure that I am current on my projects and keep up with literature, which allows me to further my projects and my undergraduate experience.”

**Where was your research experience located?**  
“University of Notre Dame”

**What did you get out of your research experience?**  
“My research experience has been a positive one. I have been able to learn about how research is conducted in a laboratory setting, and I have been able to learn and grow as a scientist. My undergraduate research experience has influenced my desire to continue my education through graduate school and pursue a career in research.”

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